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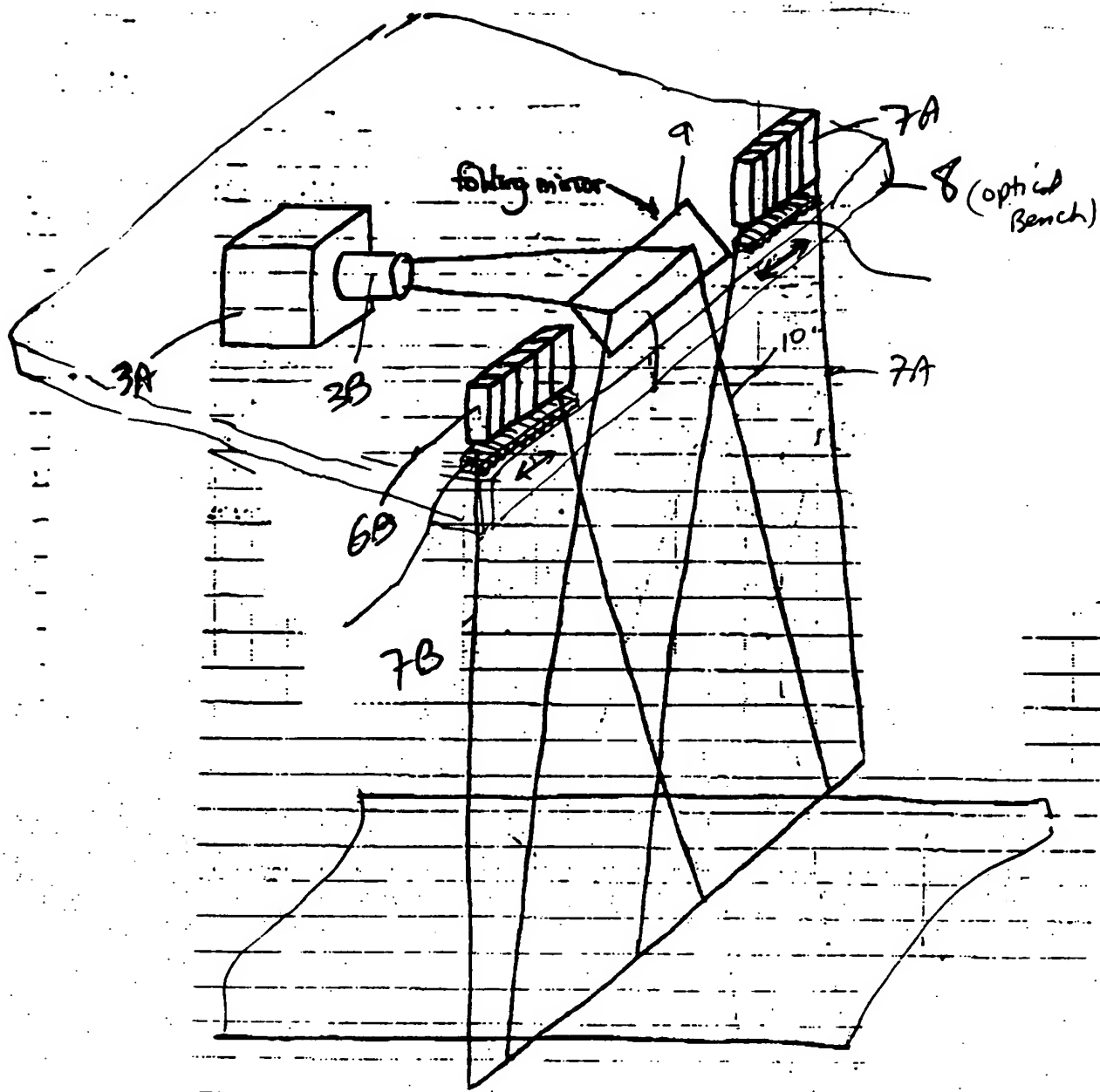


FIG 1B1

↑  
1A

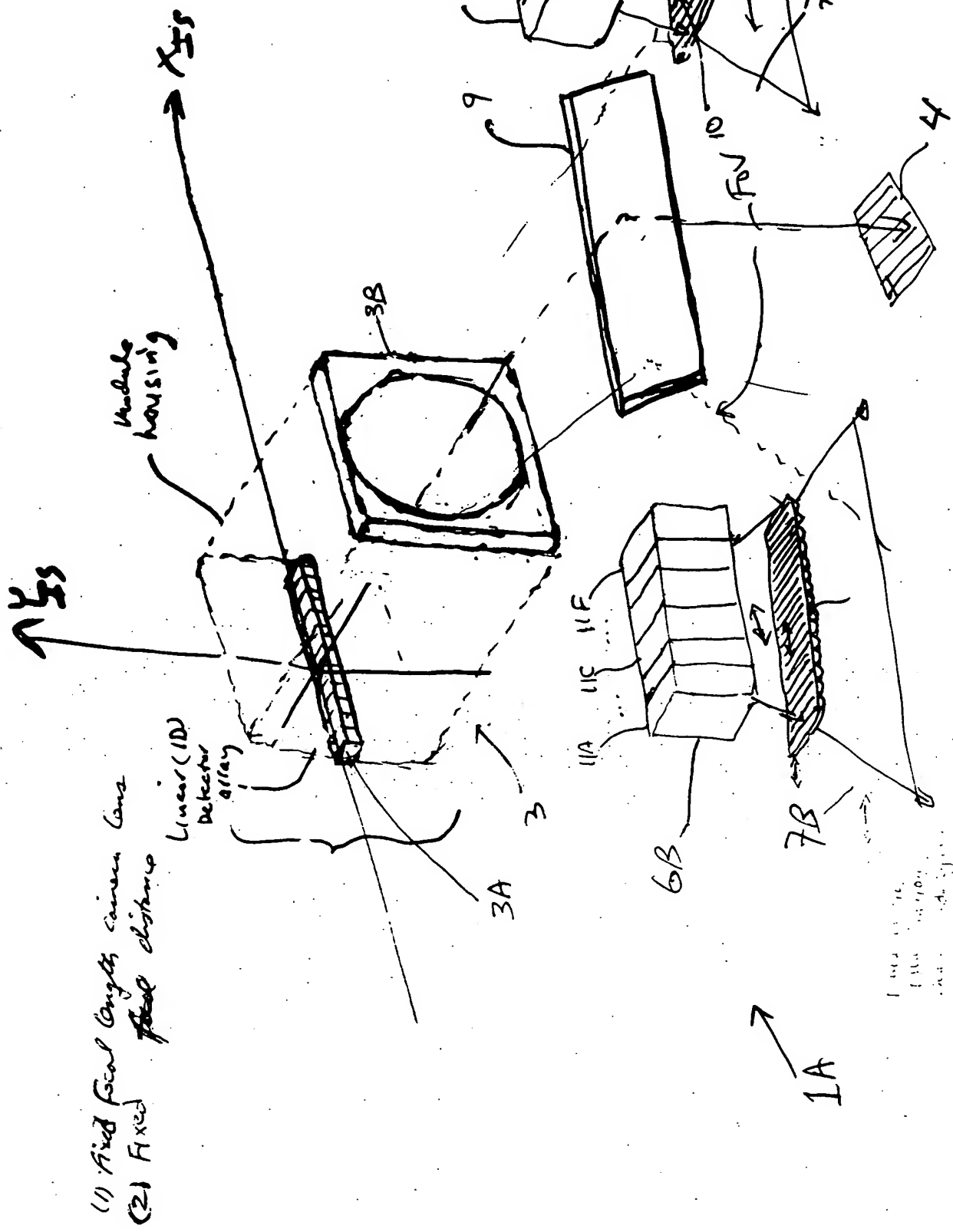


FIG. 1B2

- (1) Fixed focal length camera lens
- (2) Fixed distance

1

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$$I(y_c) = \text{gaussian}$$

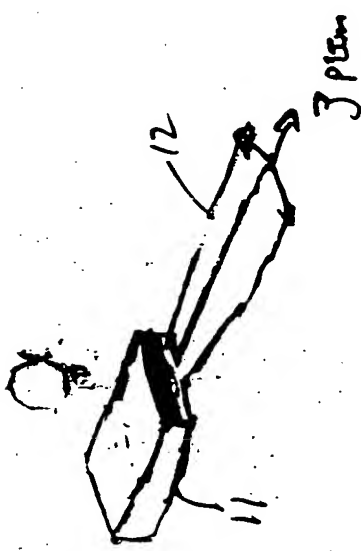


FIG. 1C

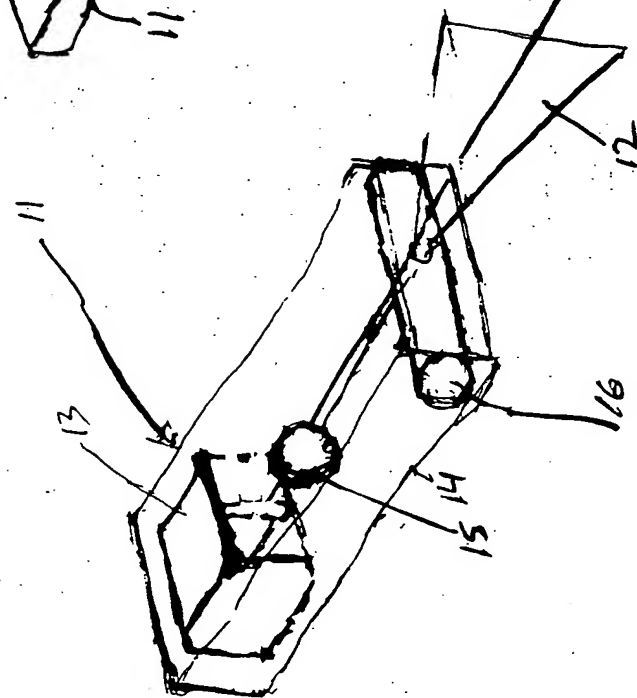


FIG. 1D

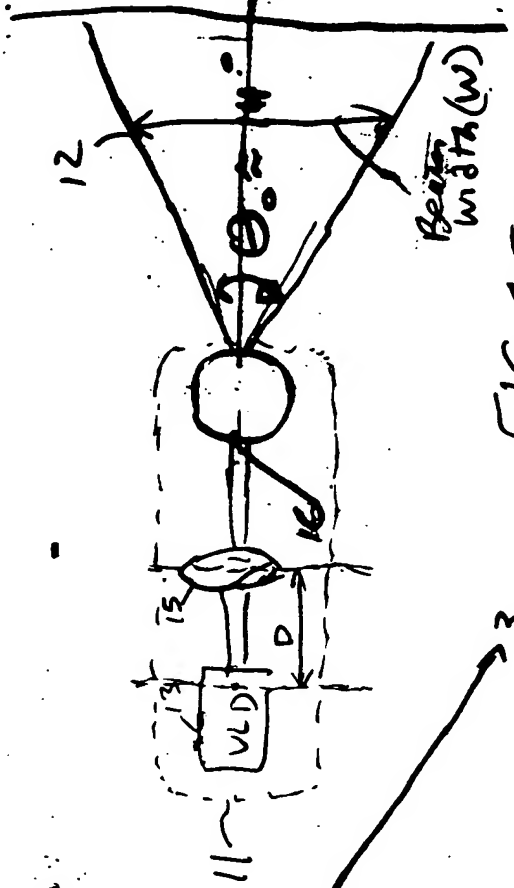


FIG. 1E1

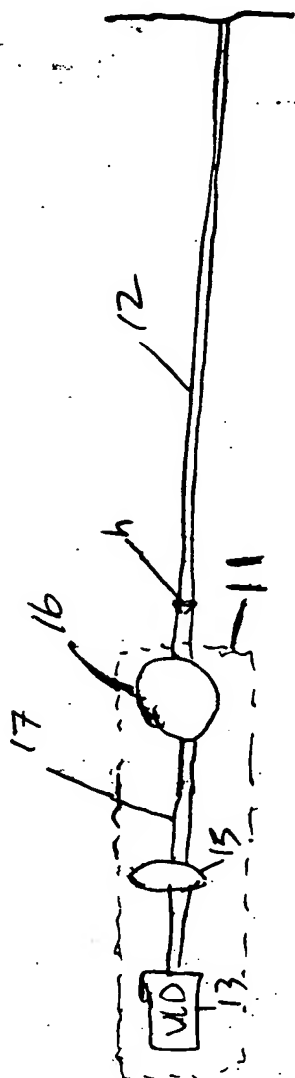


FIG. 1E2

Minimum  
object  
Range

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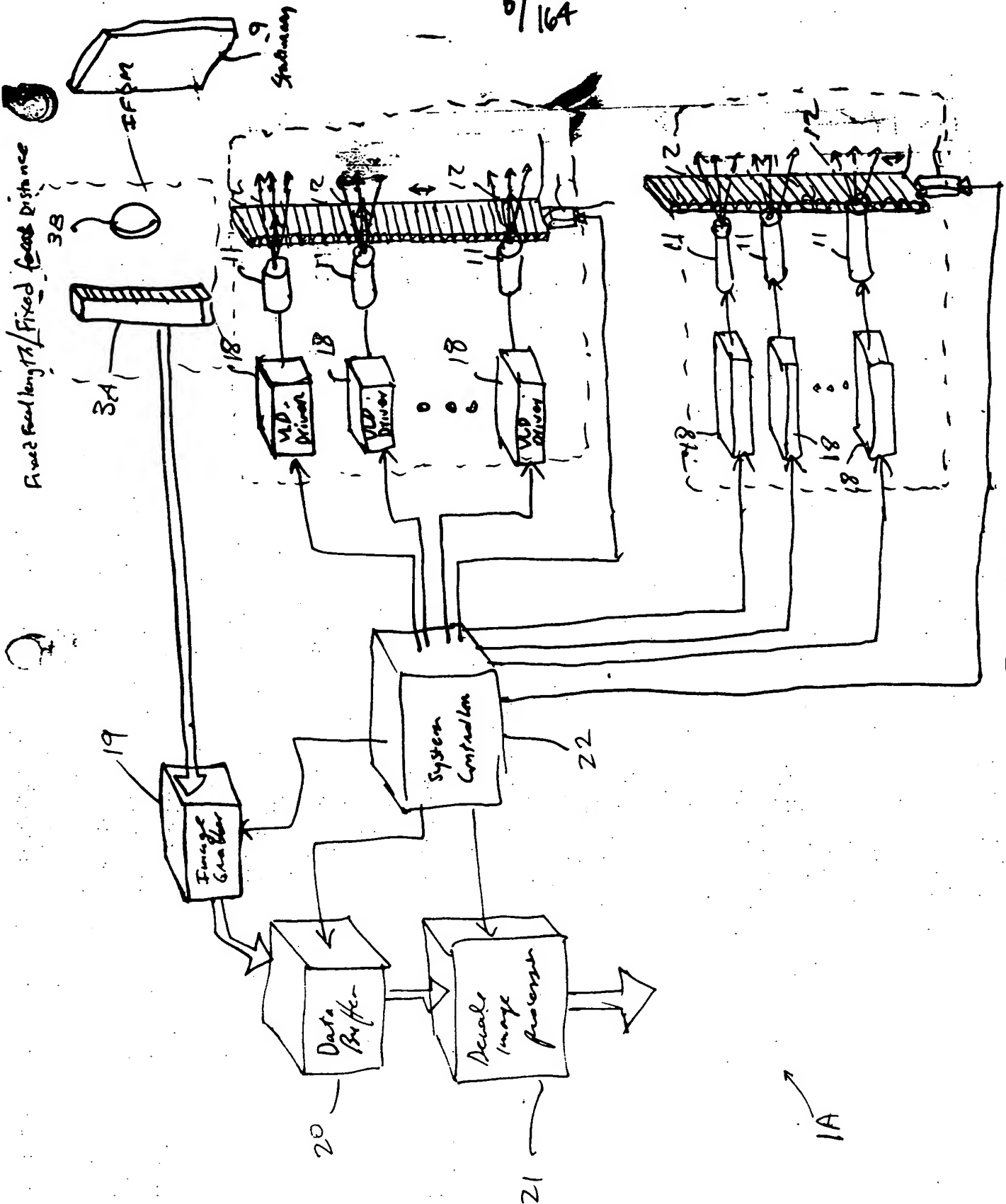


FIG. 1F

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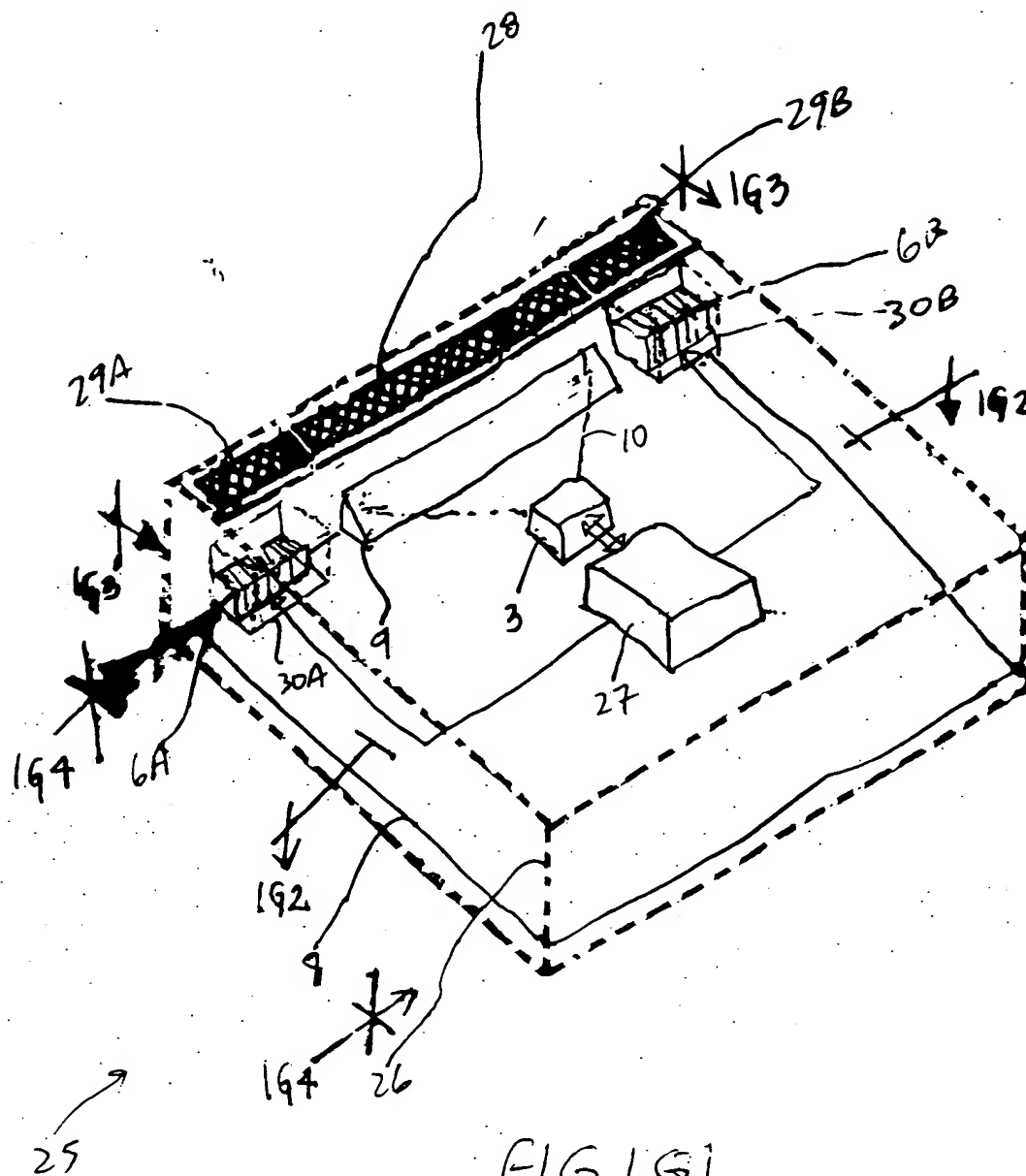


FIG 1G1

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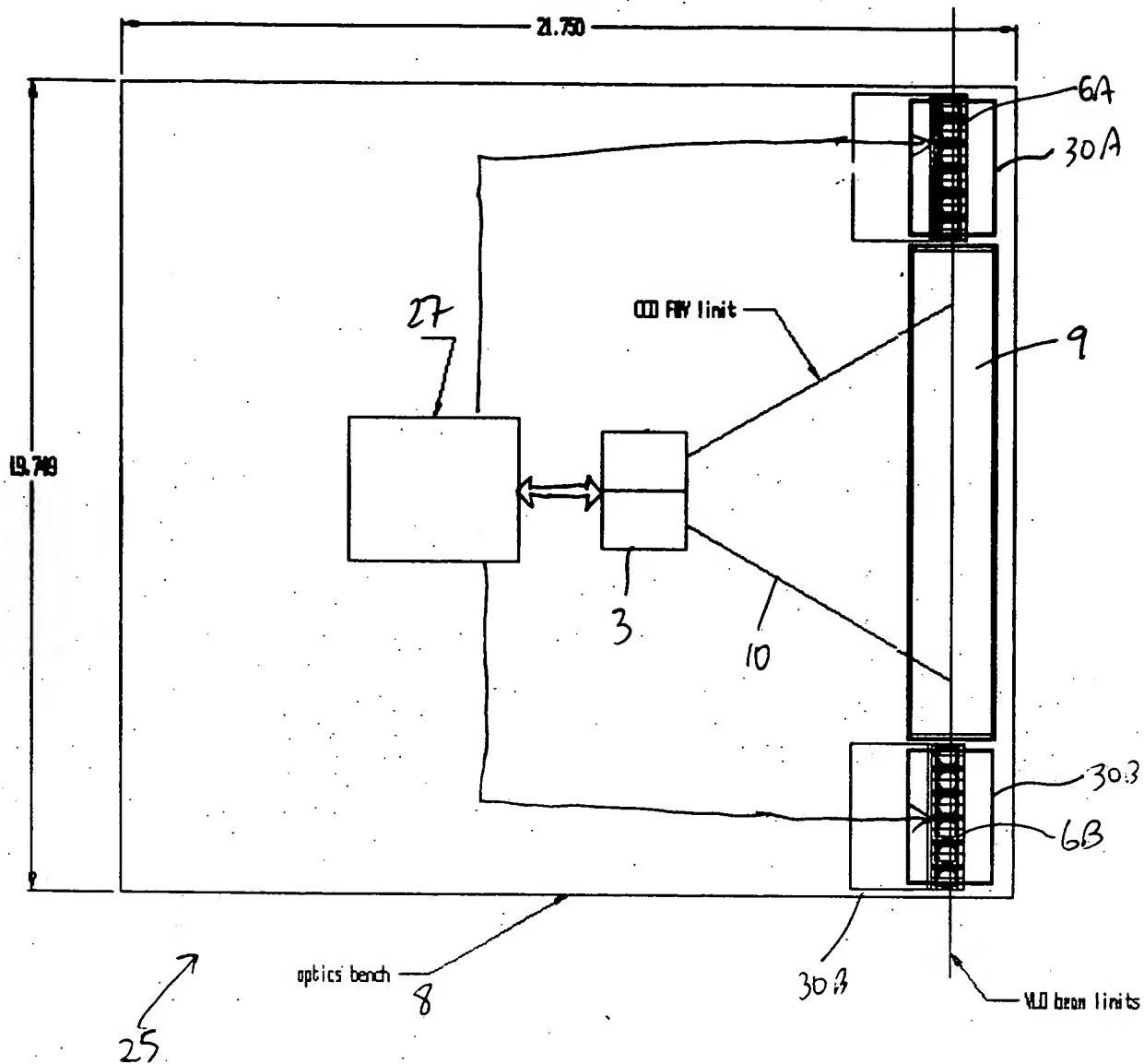


FIG. 162

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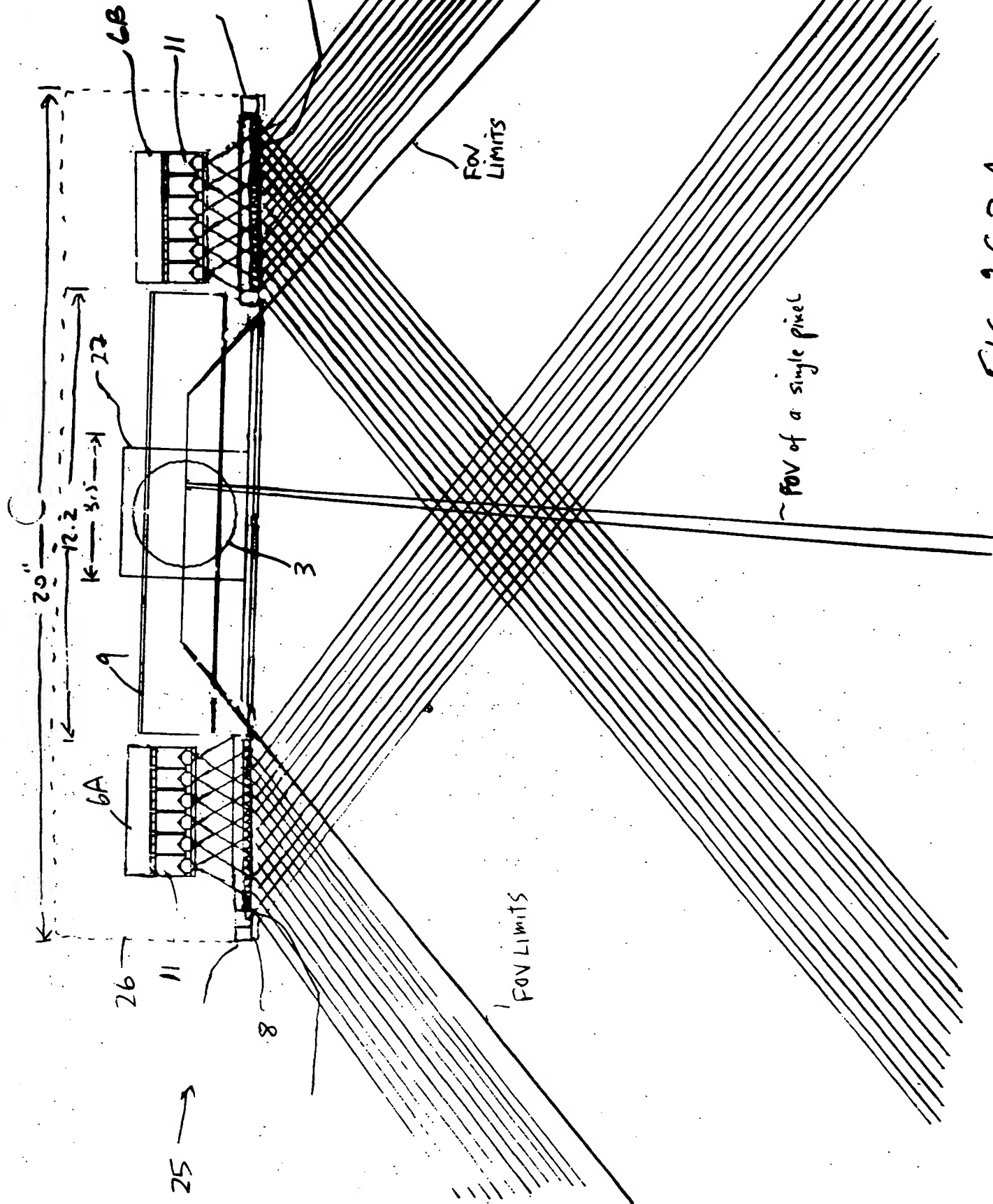


FIG 1G3A

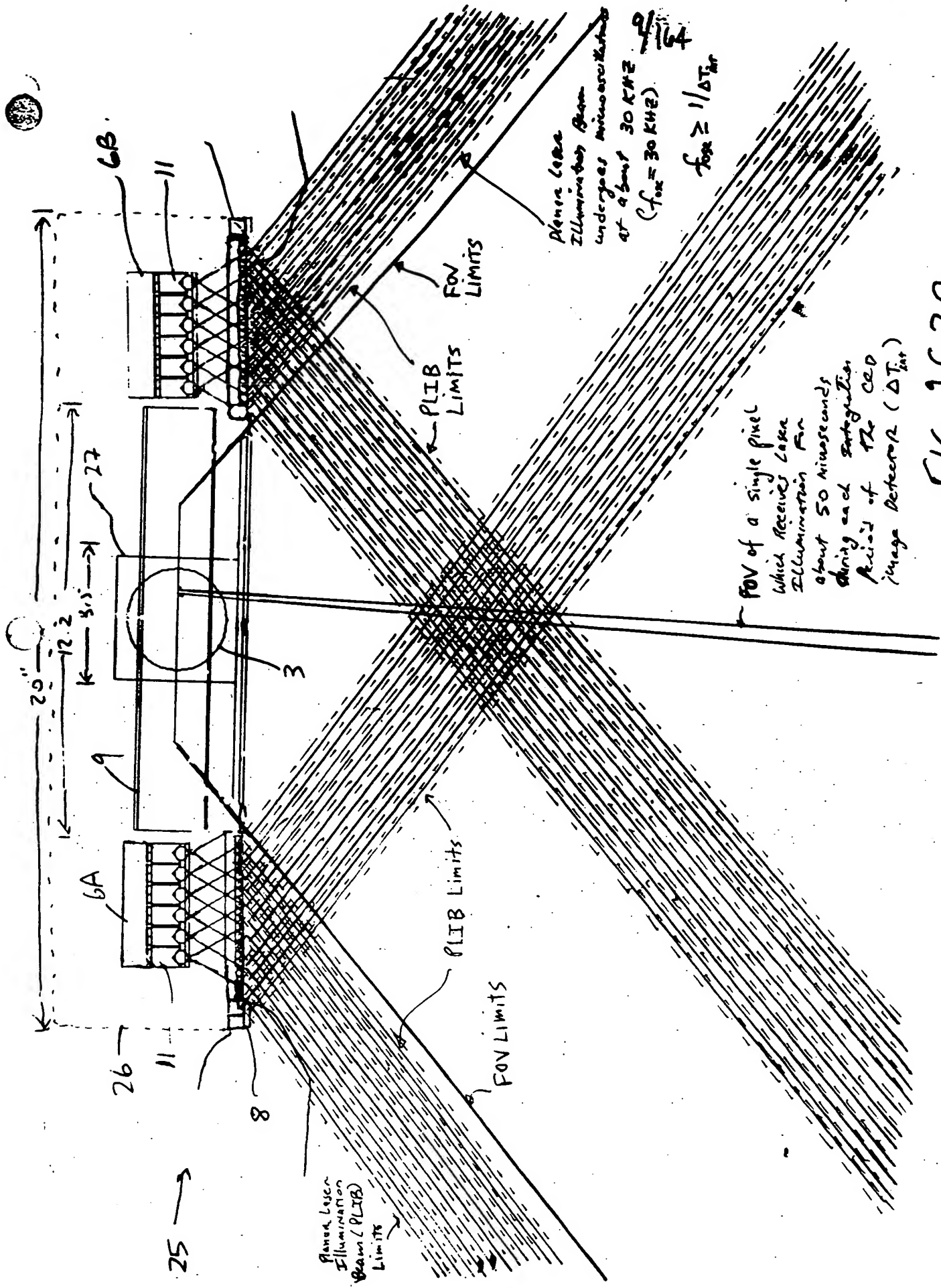


FIG 1G3B

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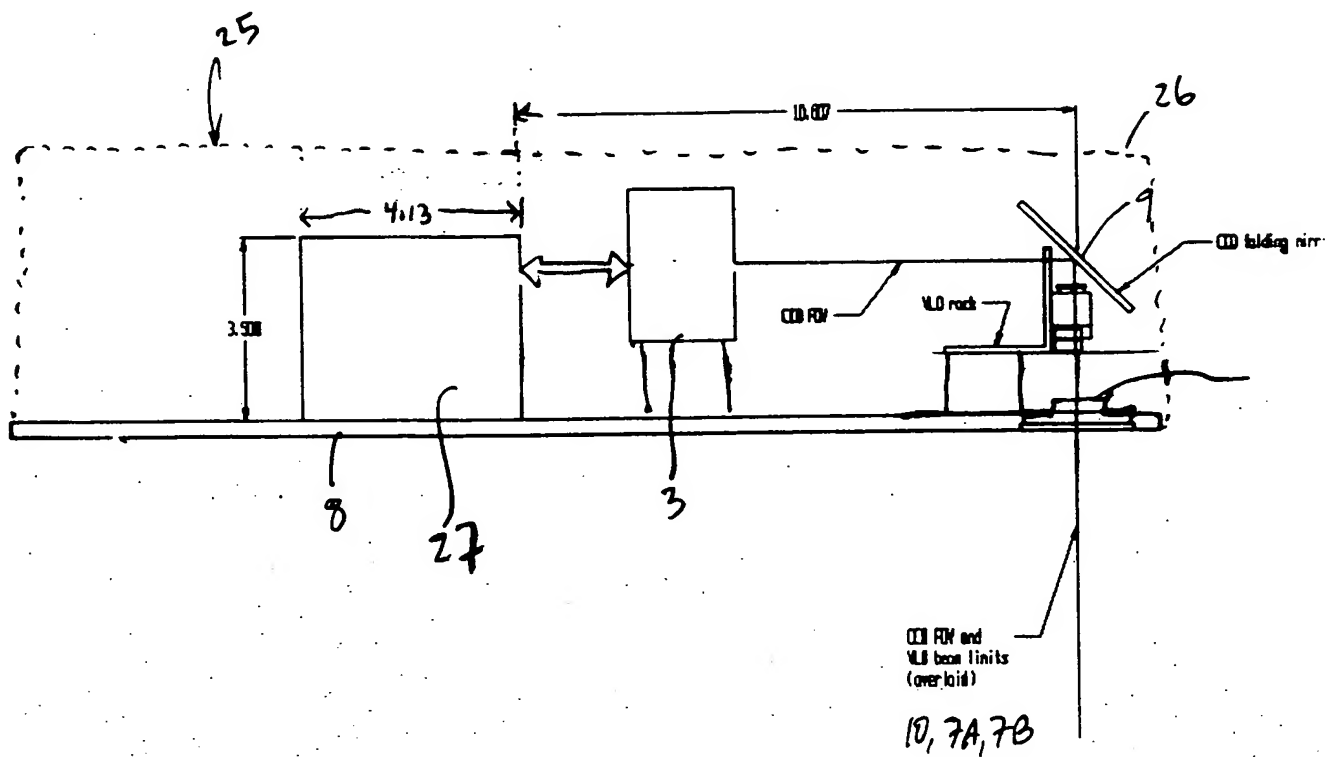
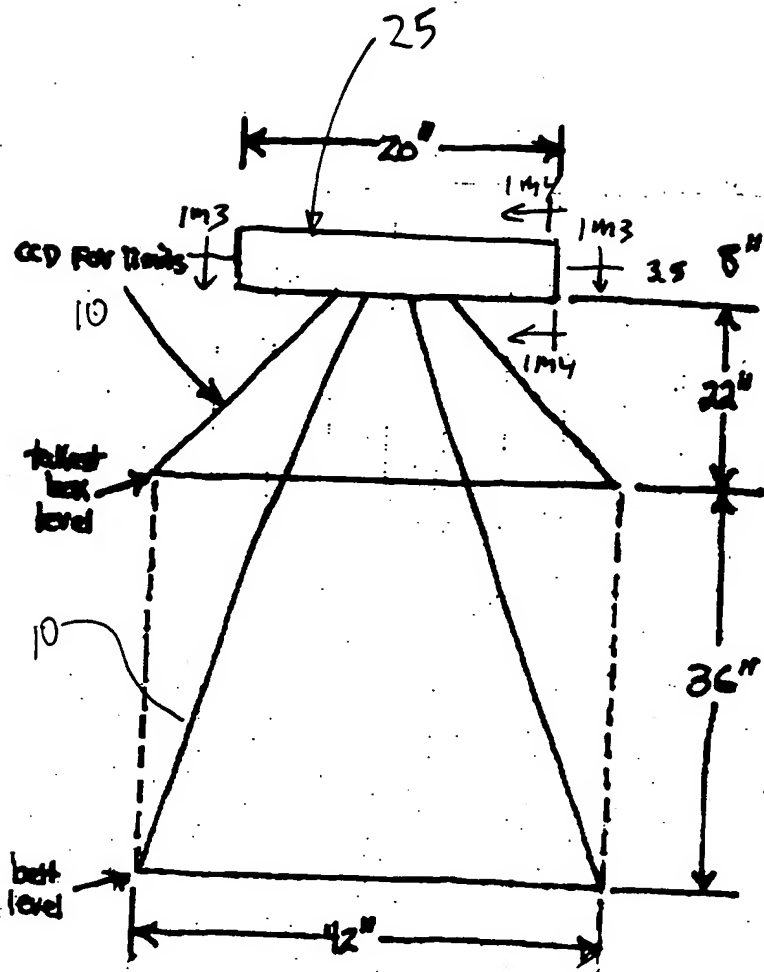


FIG. 164.

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\* Fixed Field of Field

FIG. 165

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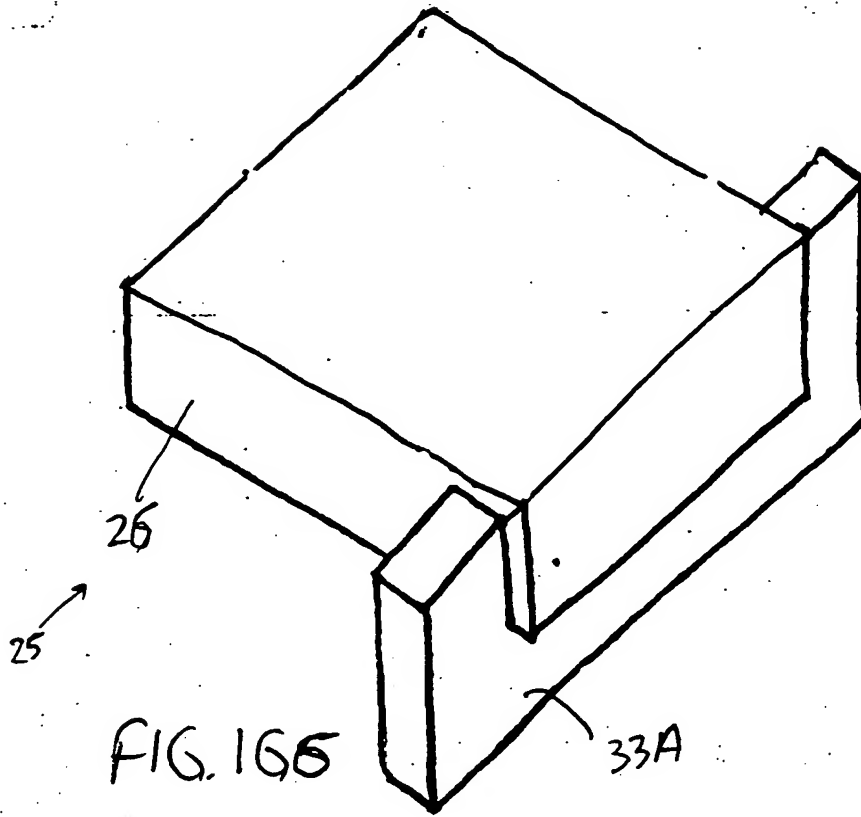


FIG. 165

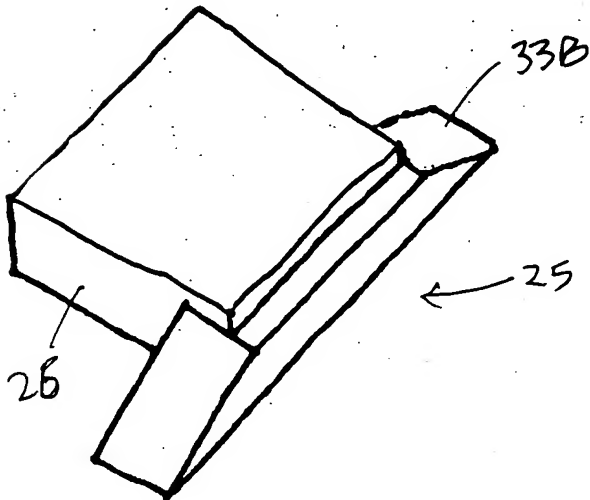
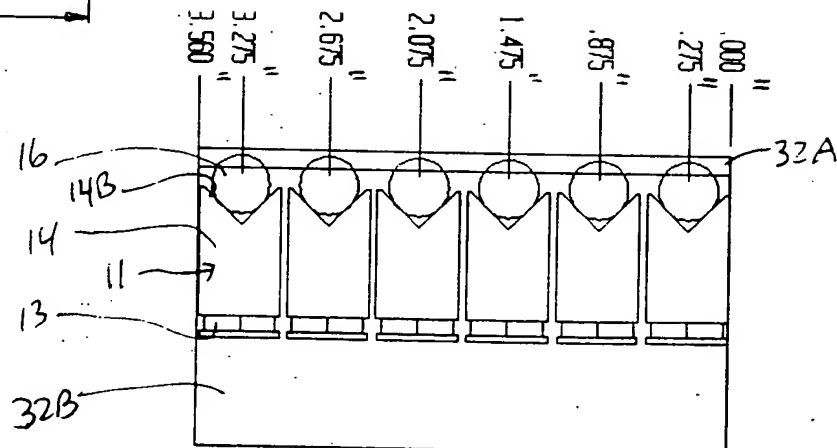
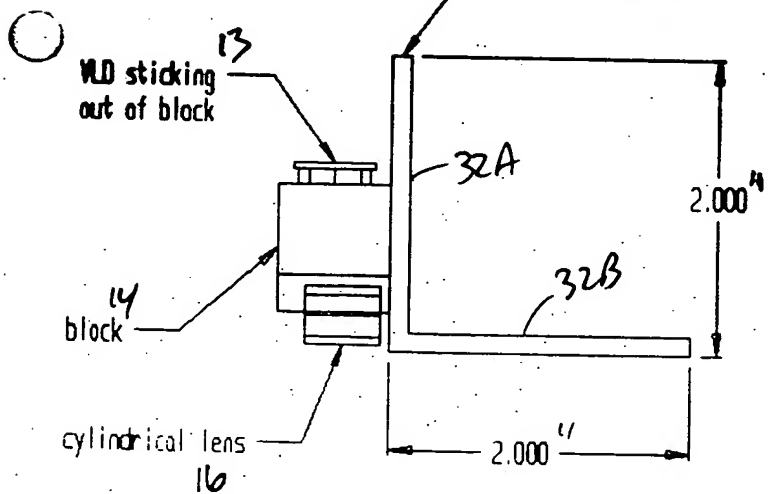
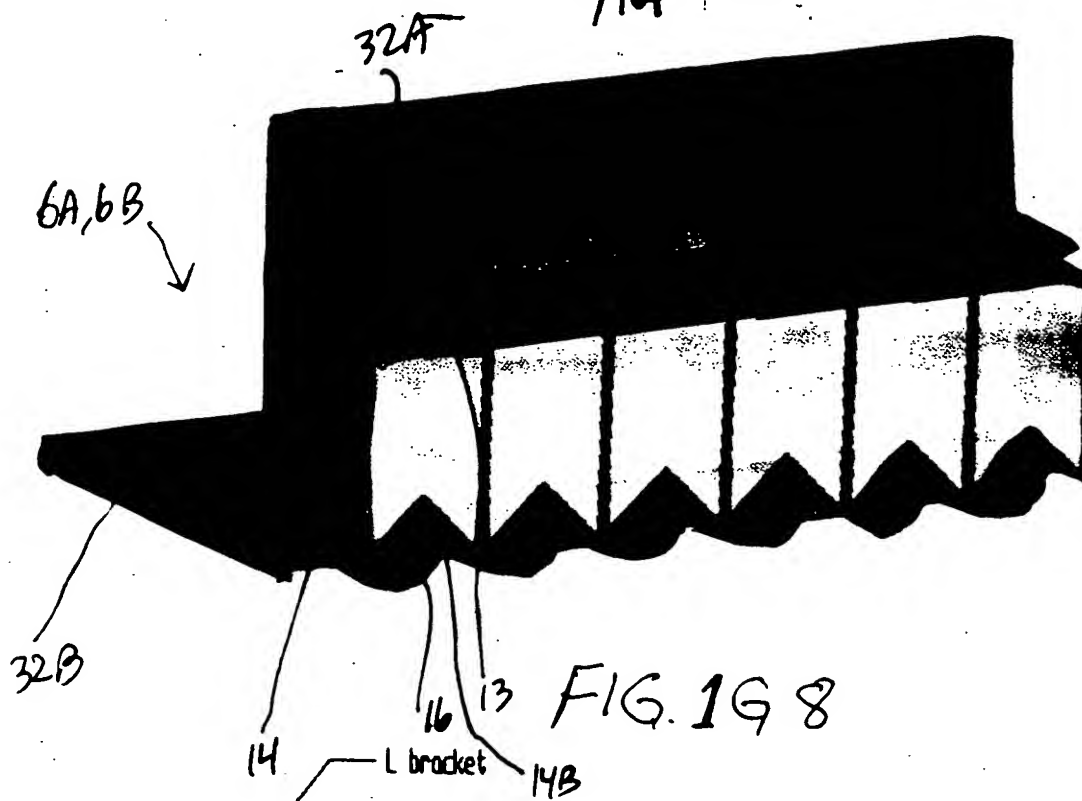


FIG. 167

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12  
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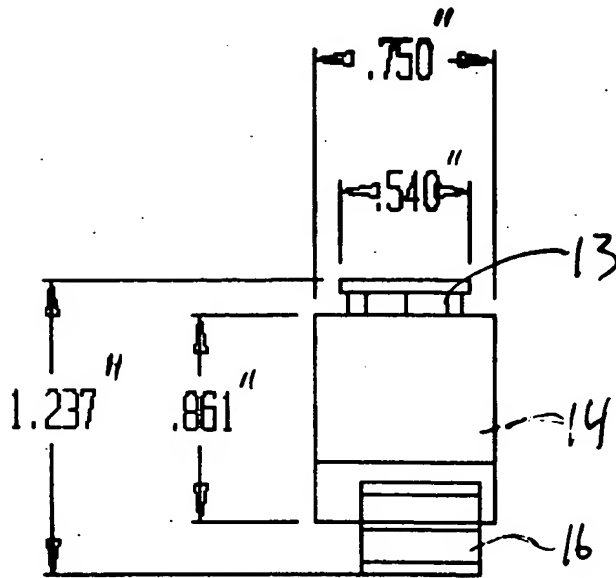


FIG. 1611

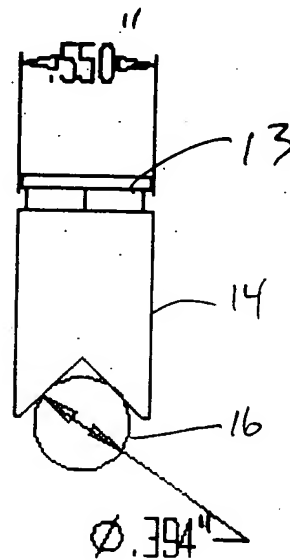


FIG. 1612

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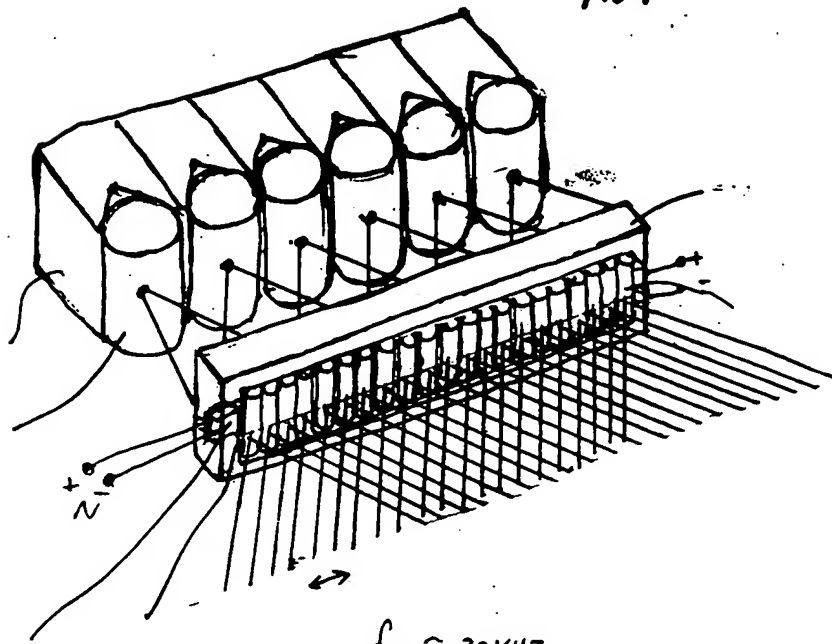


FIG. 1G13

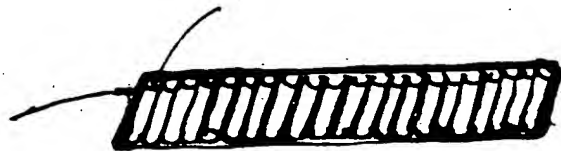


FIG. 1G14



FIG. 1G15

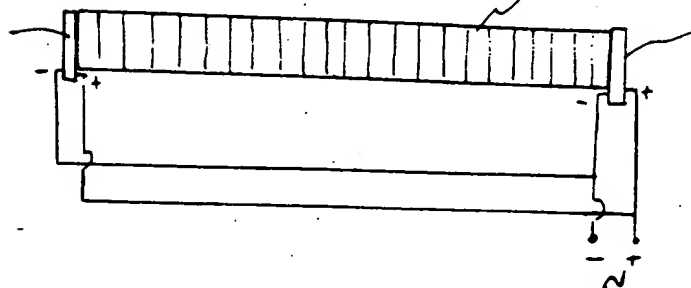
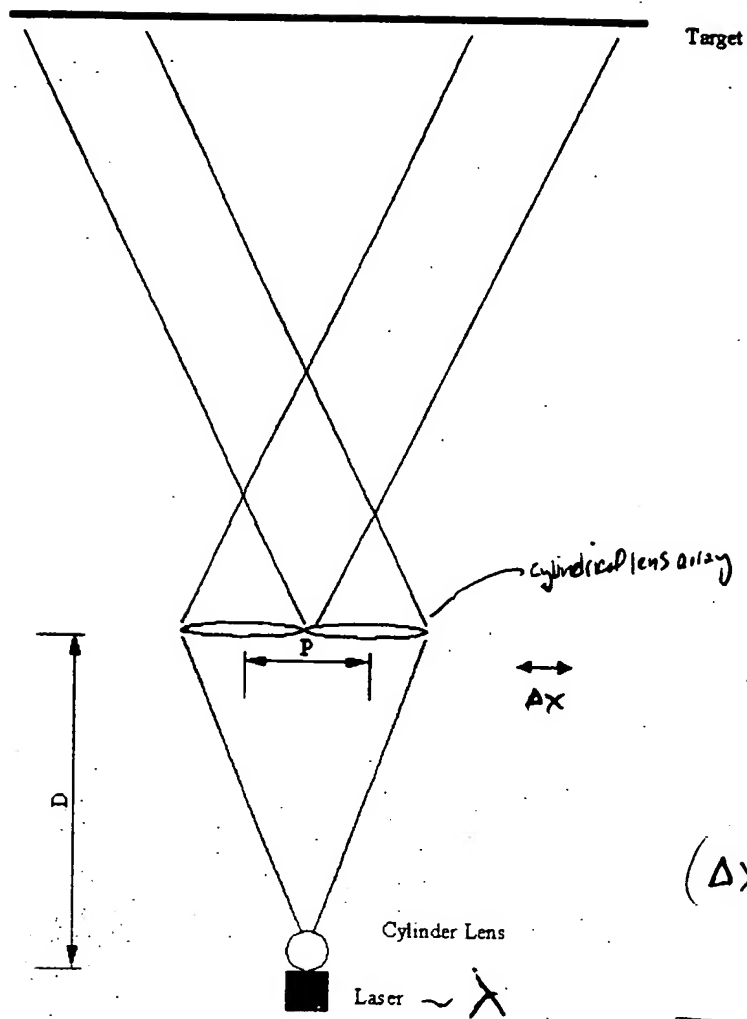


FIG. 1G16

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$$(\Delta x / D) P = \lambda$$

Figure 1

$$\Delta x \geq \frac{\lambda}{P} \cdot D$$

FIG. 1G13A

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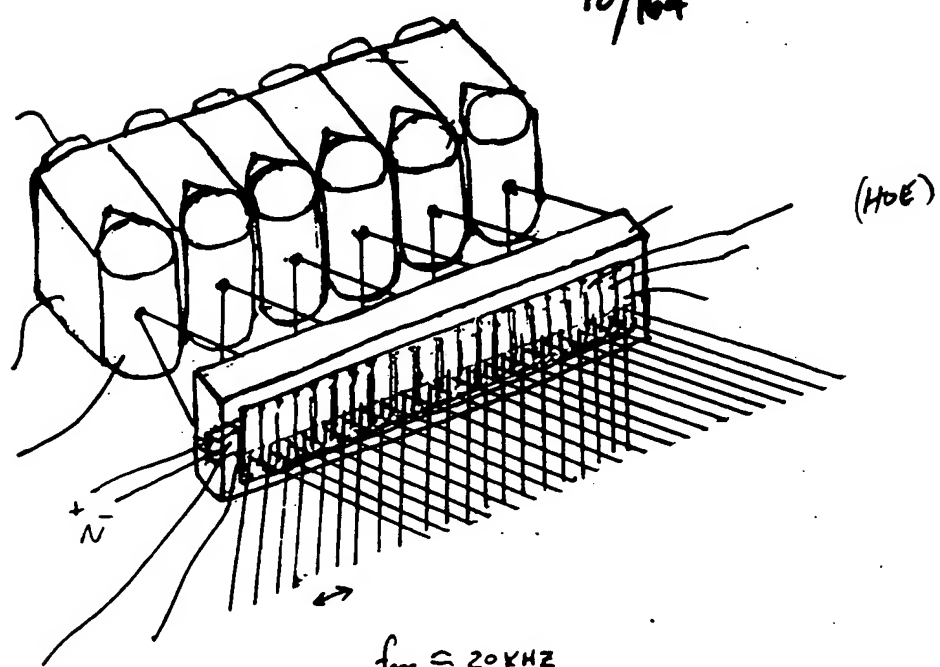


FIG. 1G13B1



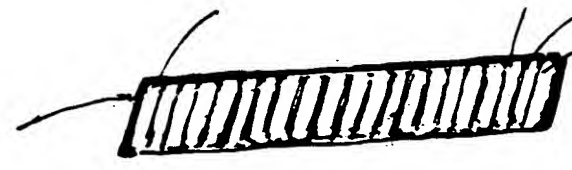
FIG. 1G13B2

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$f_{\text{osc}} \approx 20 \text{ KHZ}$

FIG 1G17



holographically-fabricated  
cylindrical lens array

FIG. 1G18

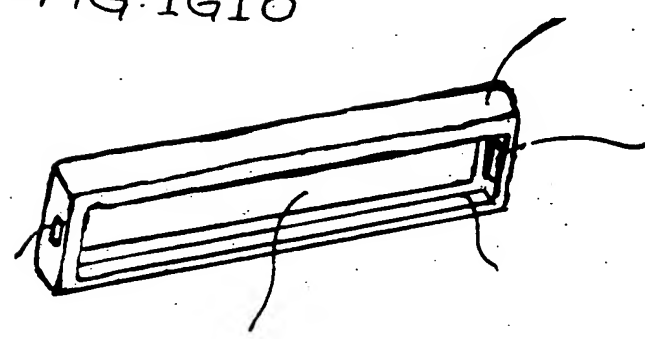


FIG 1G19

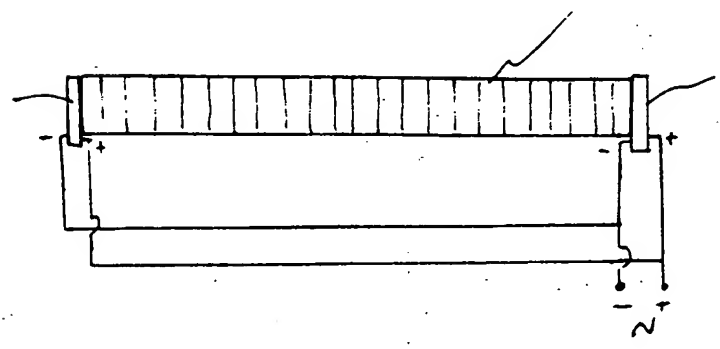


FIG. 1G20

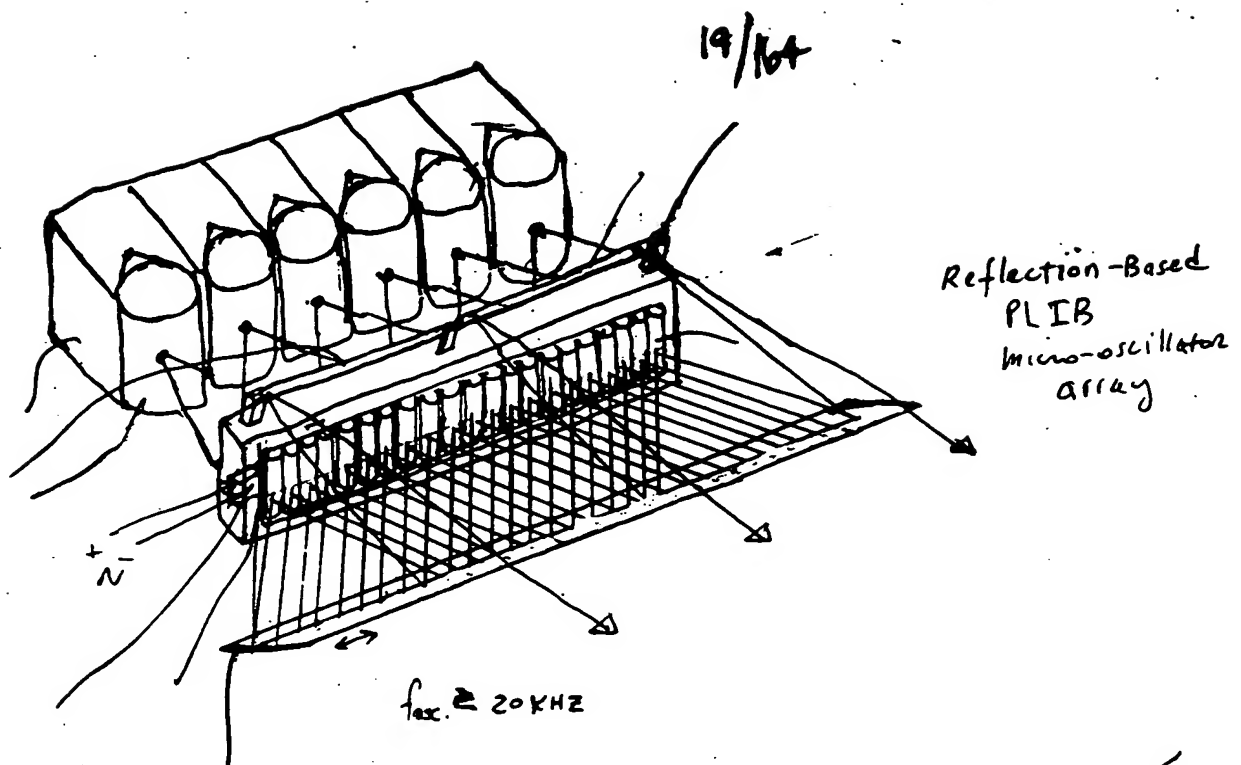


FIG. 1G.21

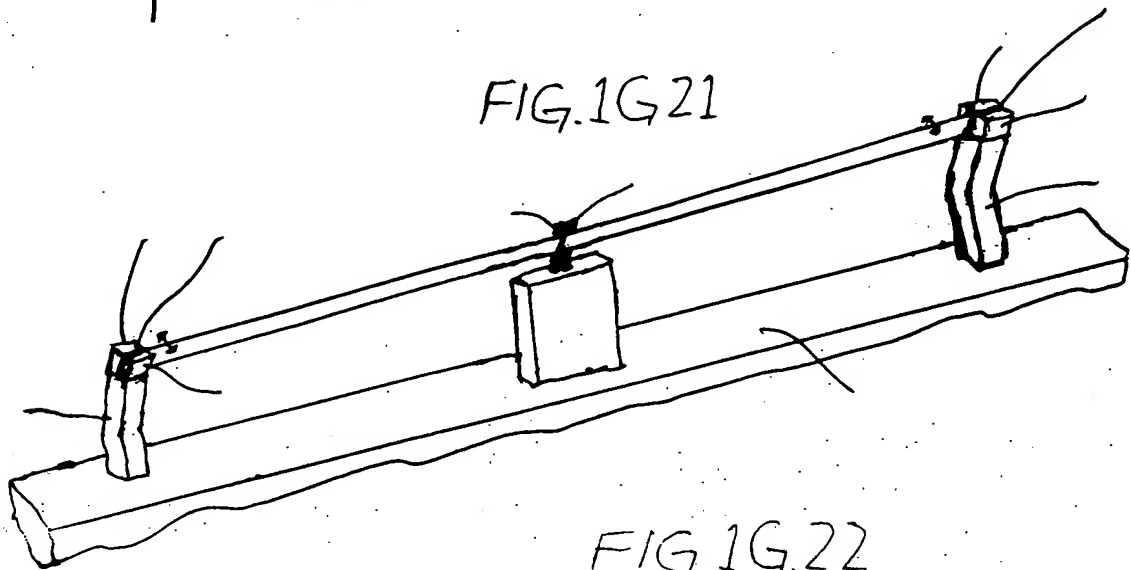


FIG. 1G.22

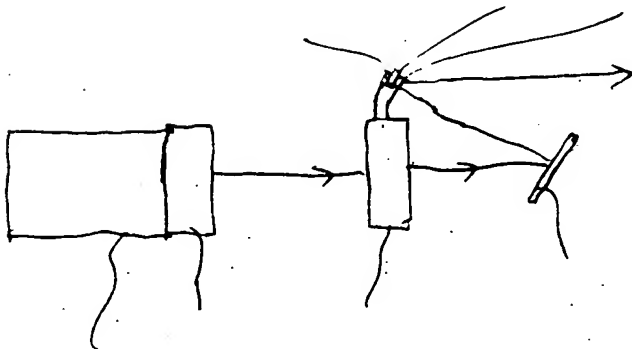


FIG. 1G.23

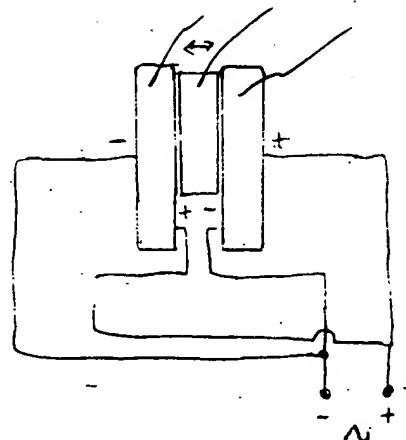


FIG. 1G.24

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Beam  
Deflection  
Control  
Signals

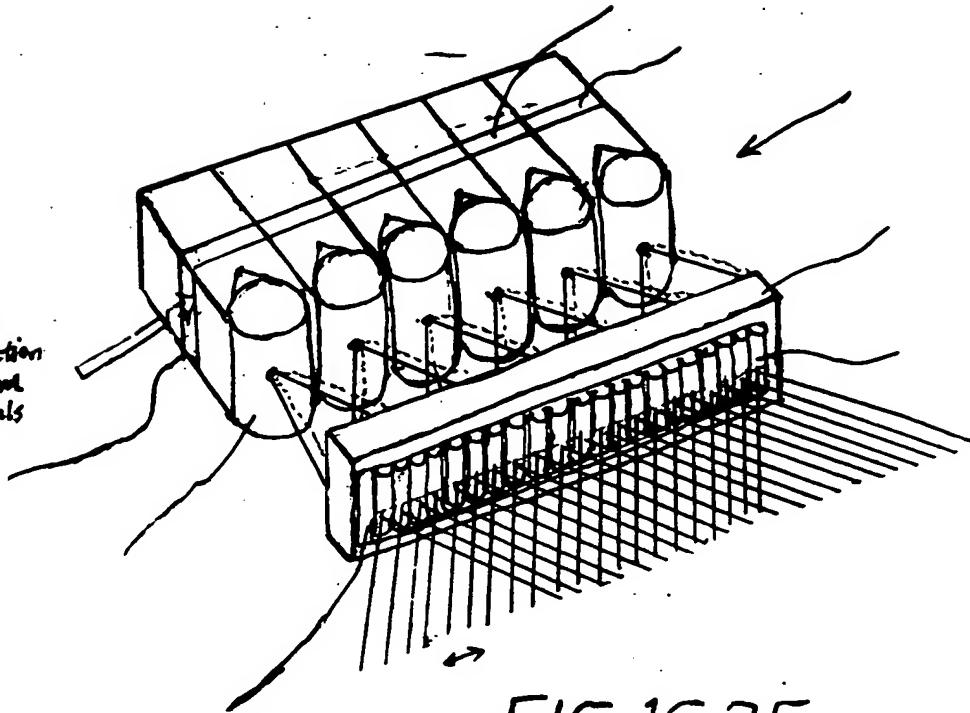


FIG. 1G25

Beam deflection  
control signals  
to Acousto-optic  
Bragg Cells

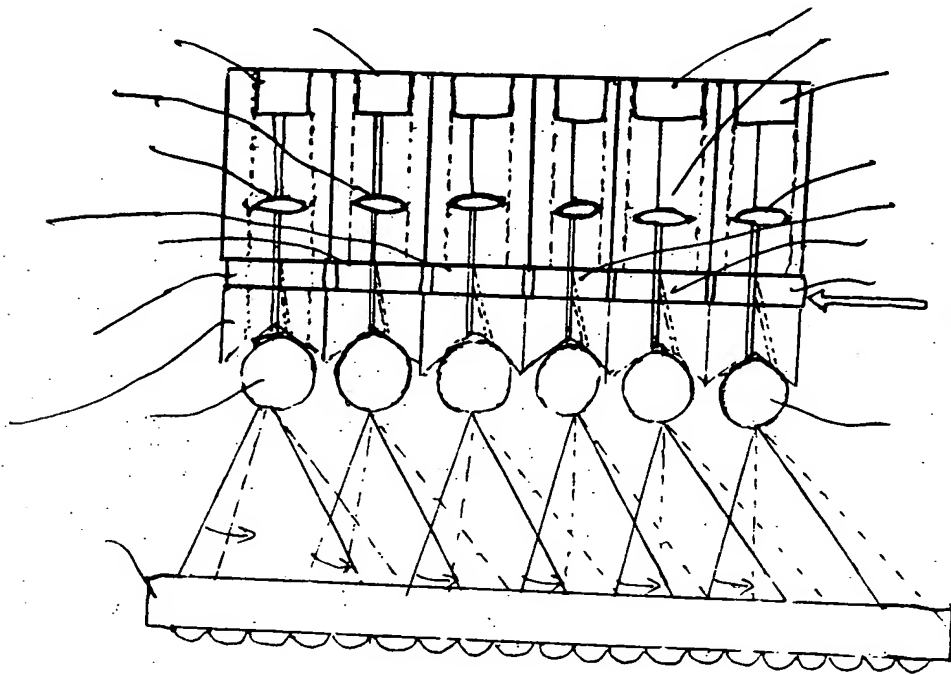


FIG. 1G26

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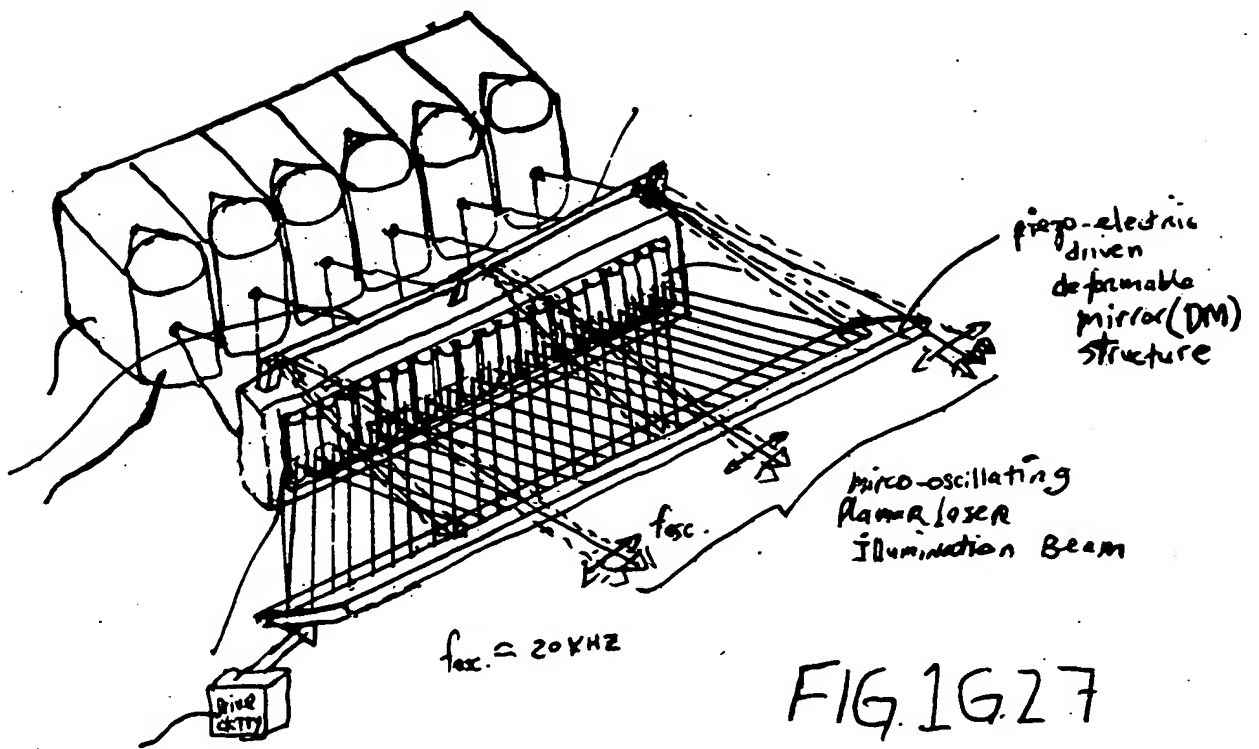


FIG. 16.27

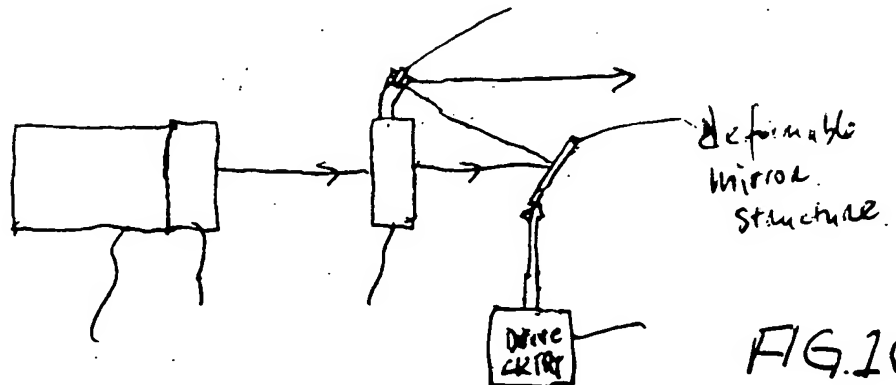
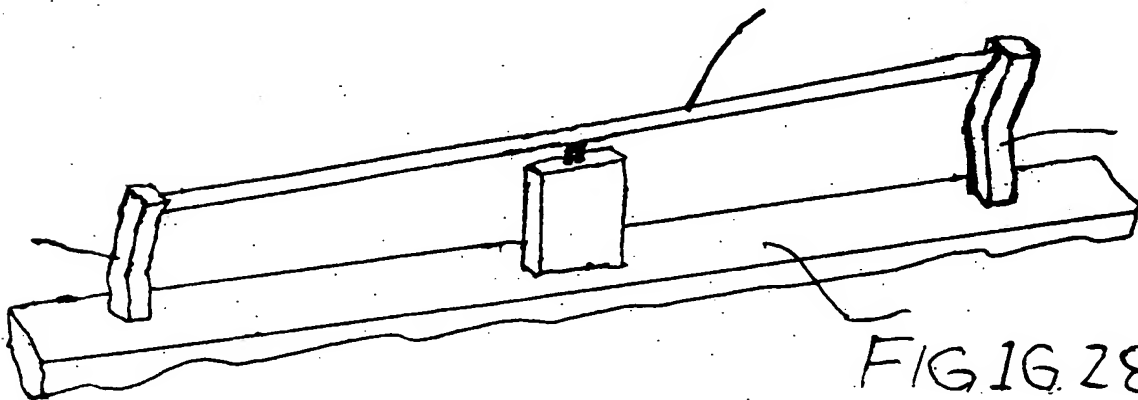


FIG. 16.29

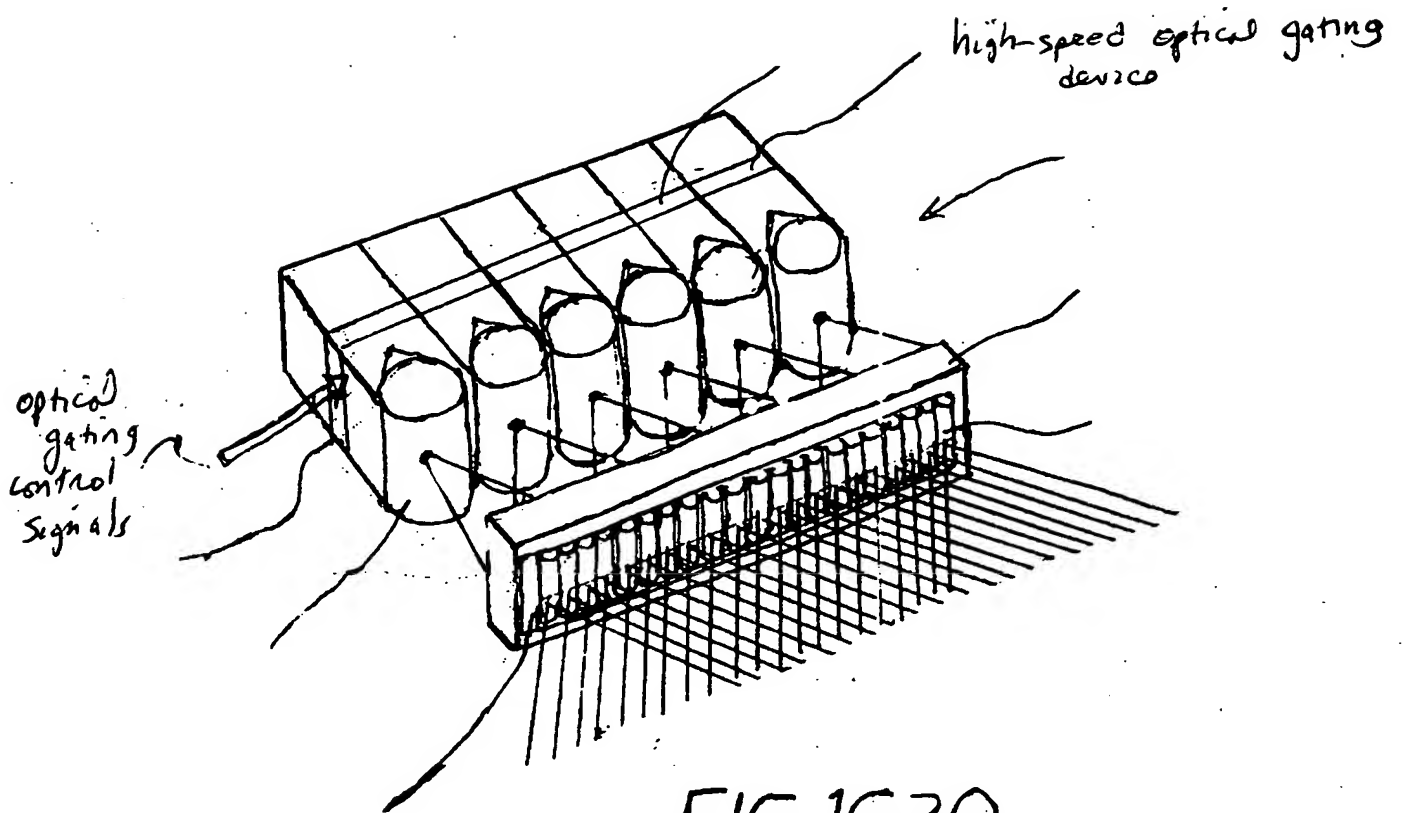


FIG. 1G30

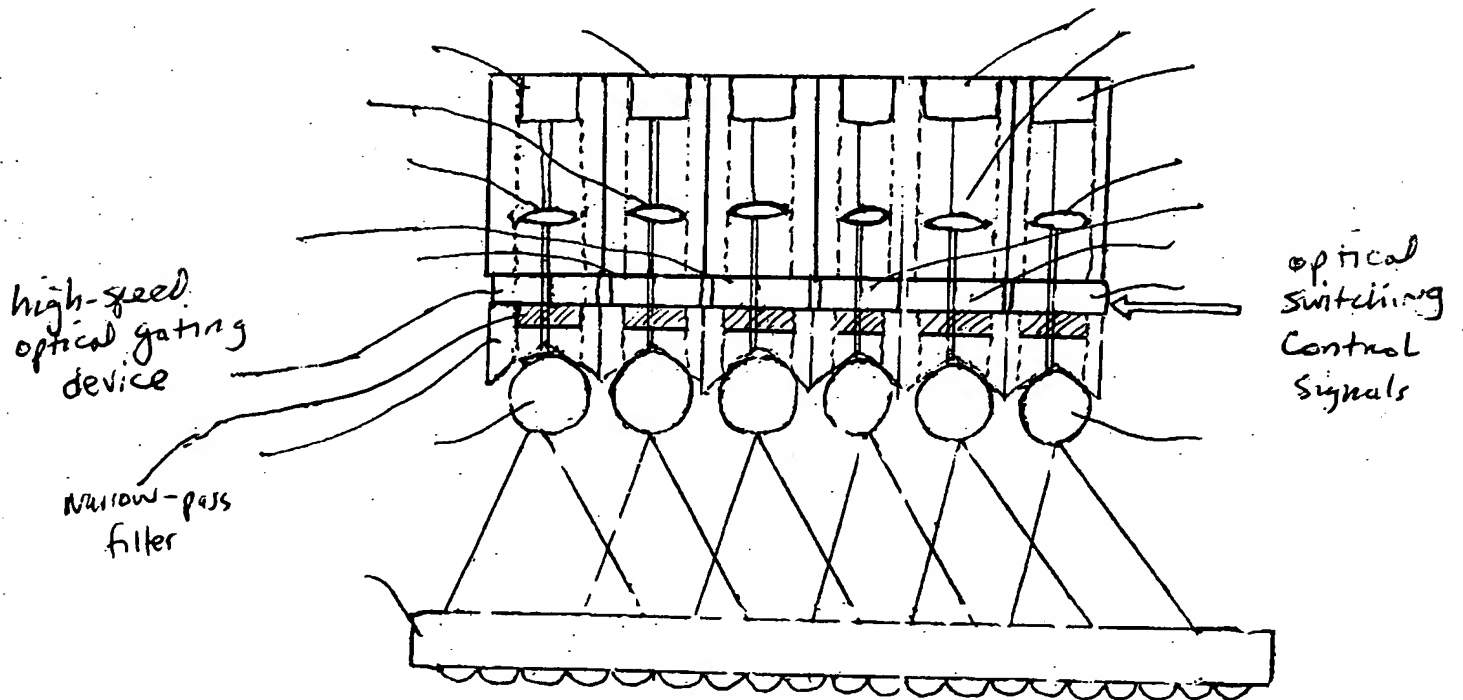


FIG. 1G31

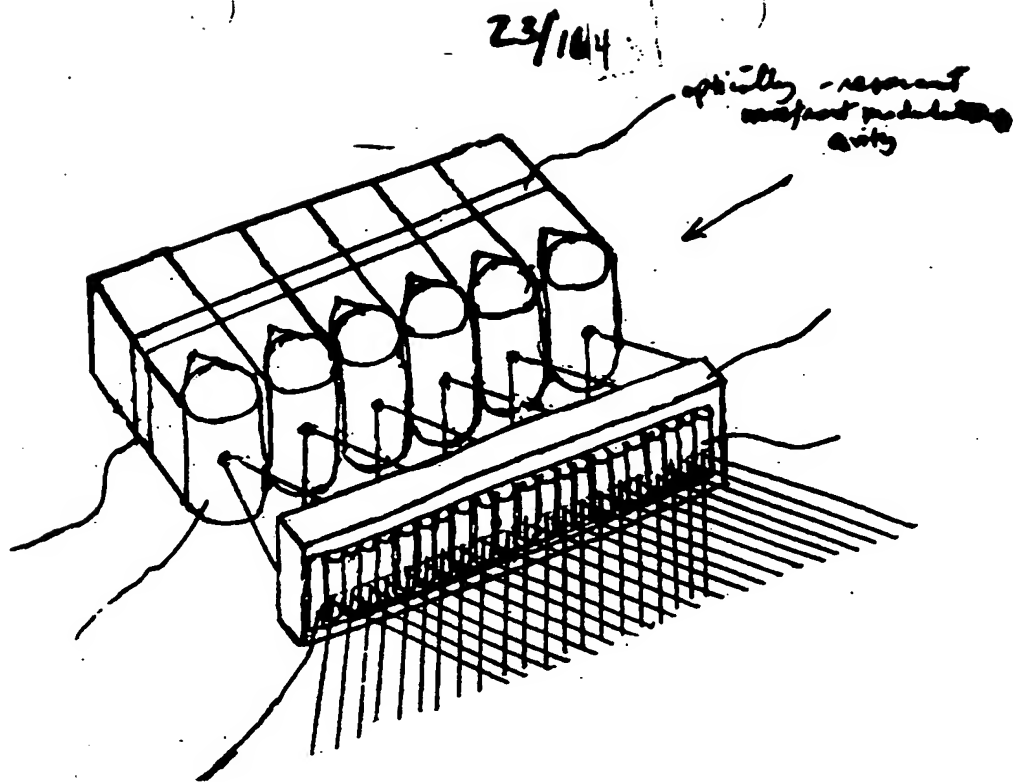


FIG 1632

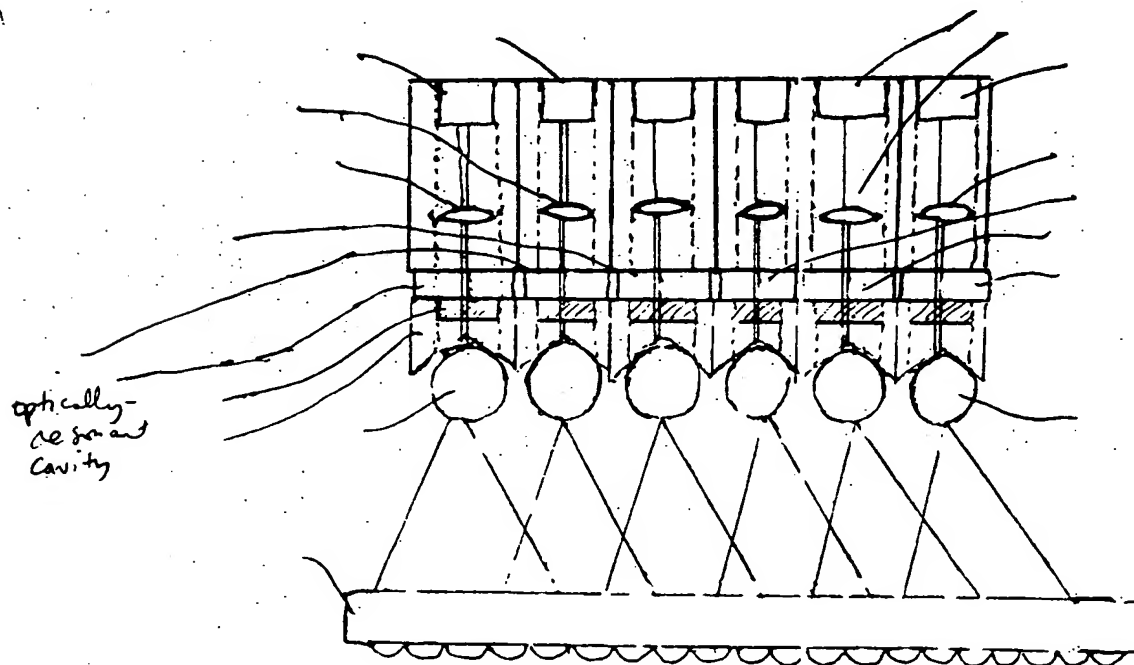


FIG 1633

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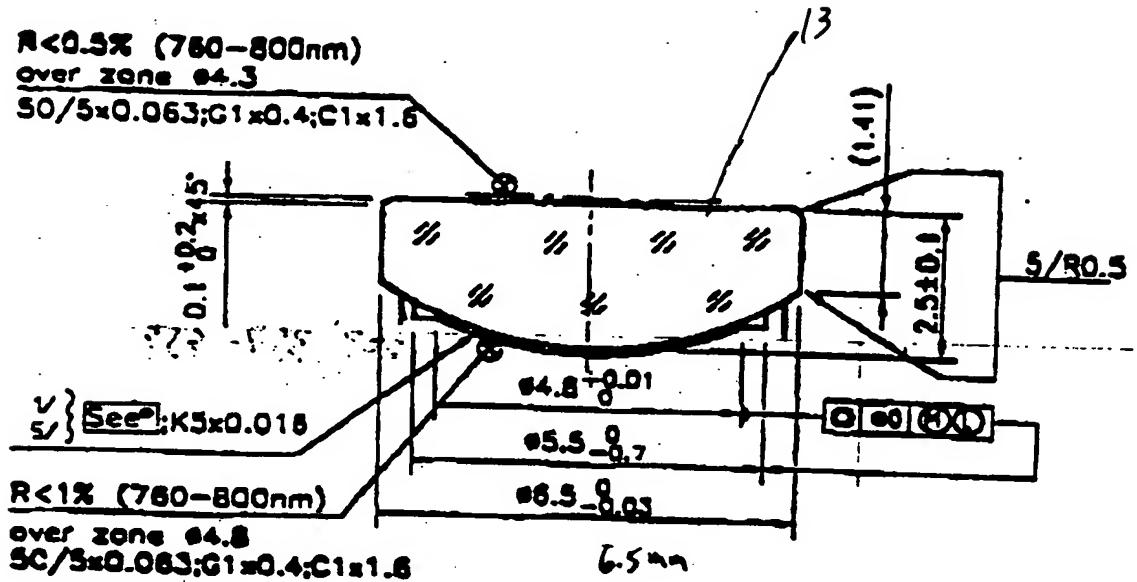


FIG. 1H1

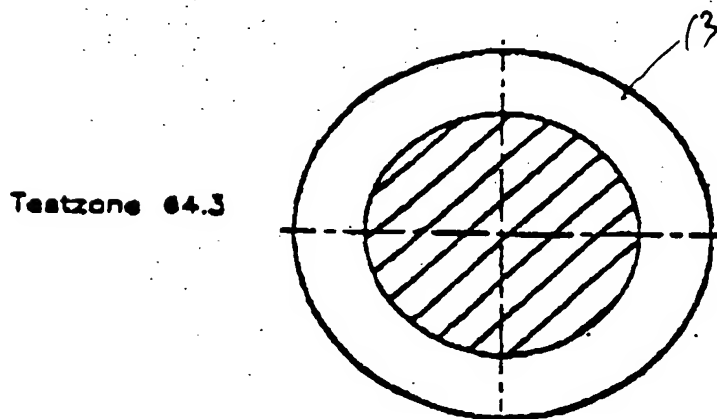


FIG. 1H2

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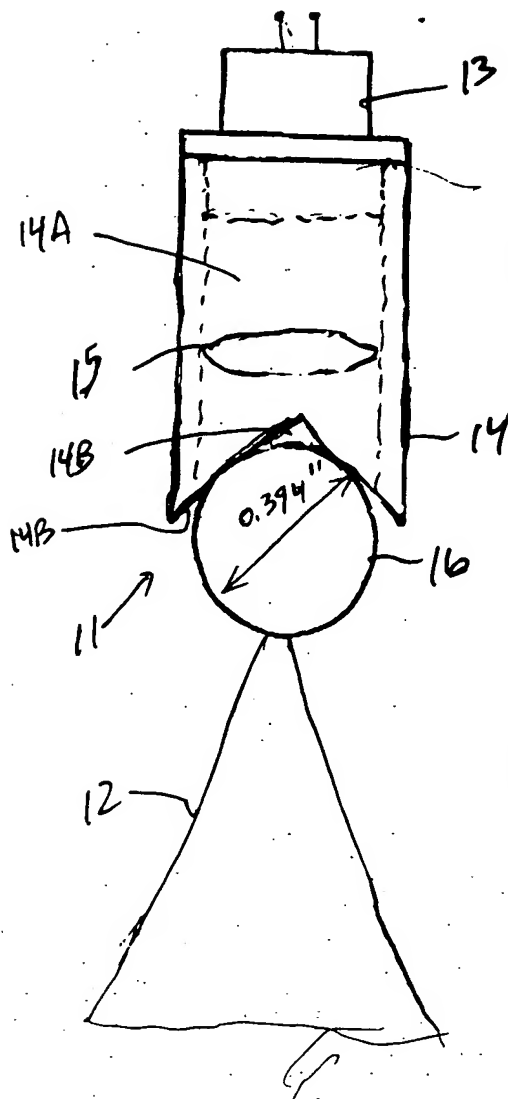


FIG 1I1

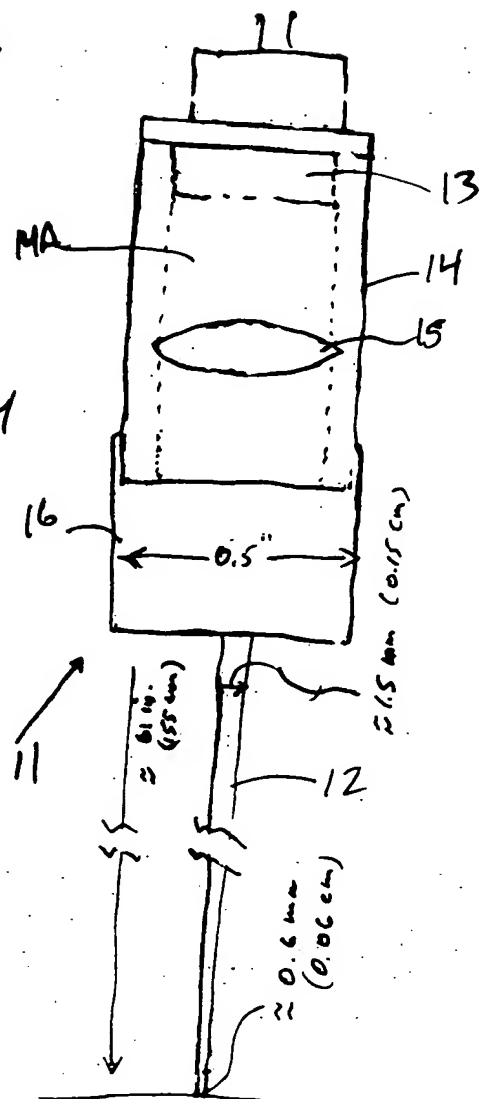


FIG 1I2

furthest  
object/working  
distance

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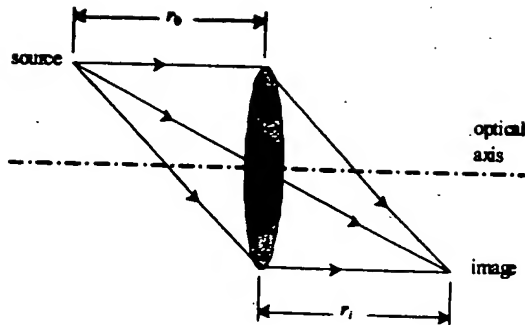


FIG. 1J1

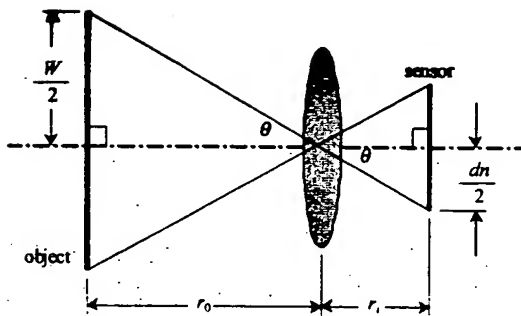


FIG. 1J2

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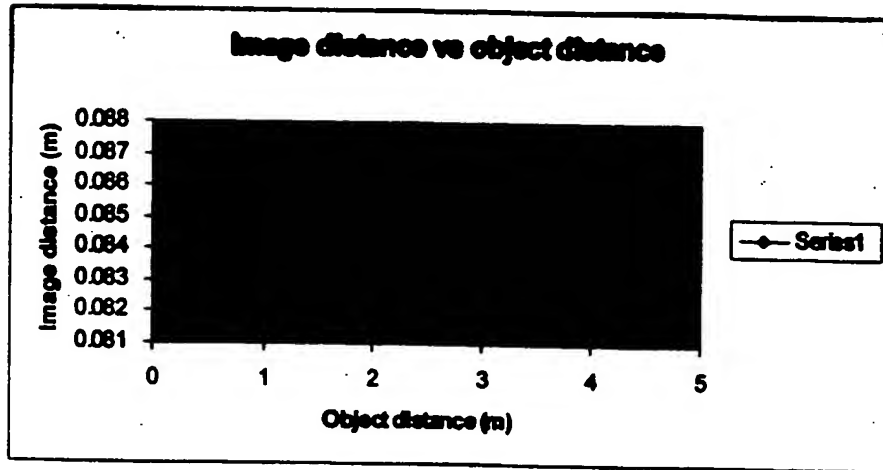


FIG. 1J3

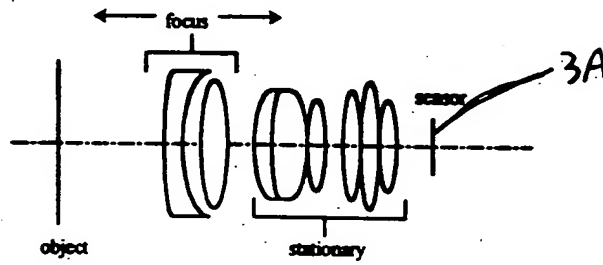


FIG. 1J4

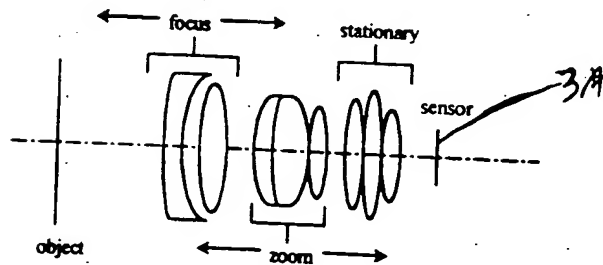
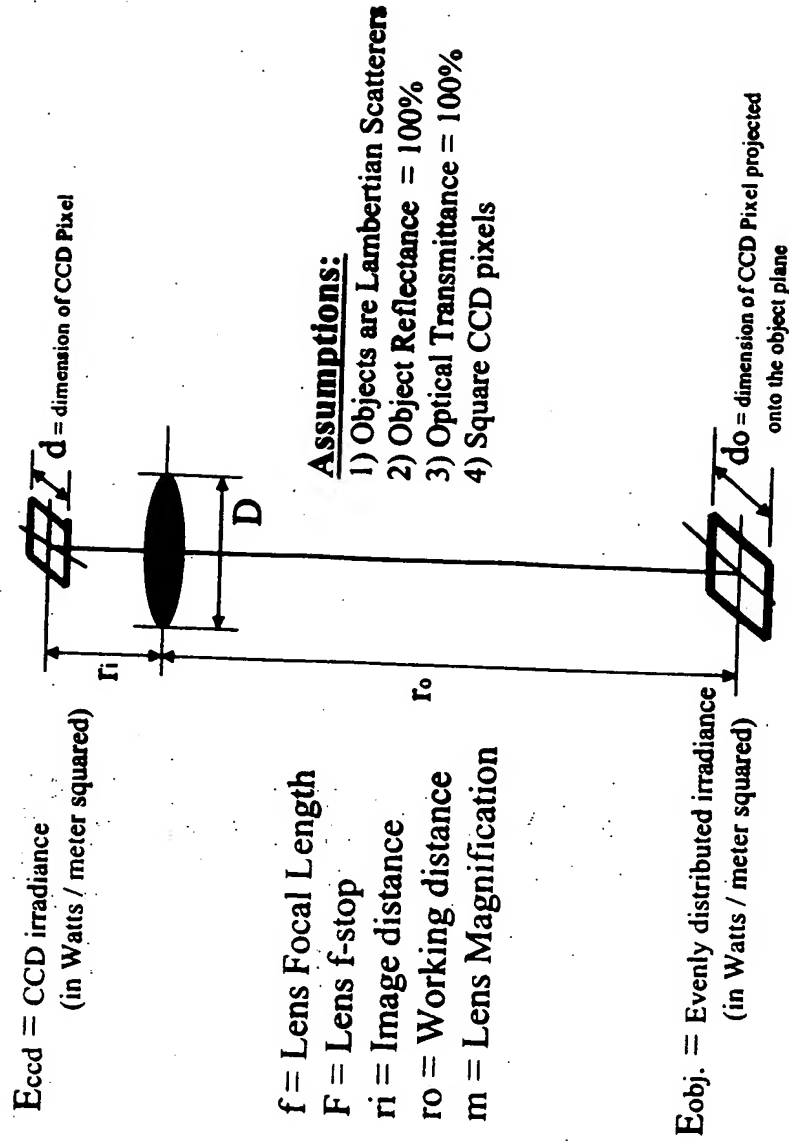


FIG. 1J5

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CCD-Based Scanner

FIG. 1J6

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Fixed focal length lens  
cases

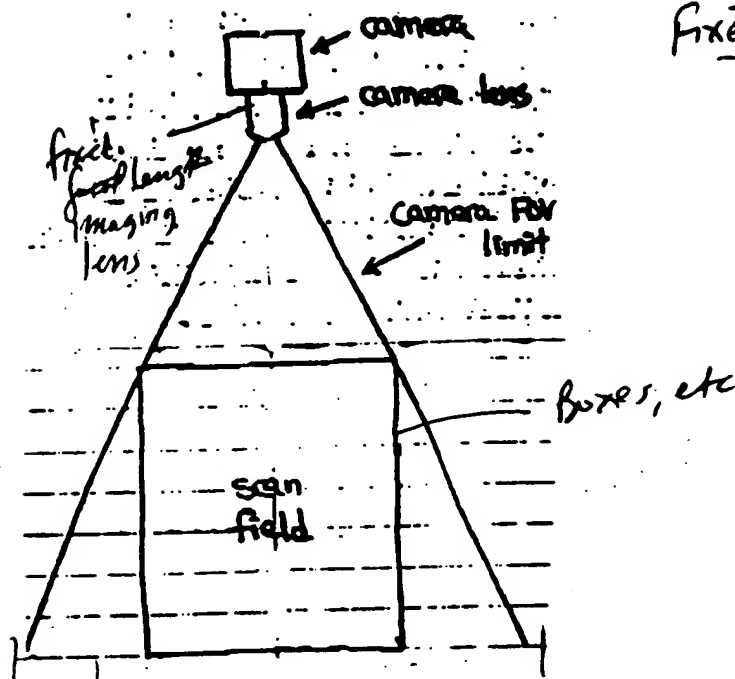


FIG 1K1  
converge 34

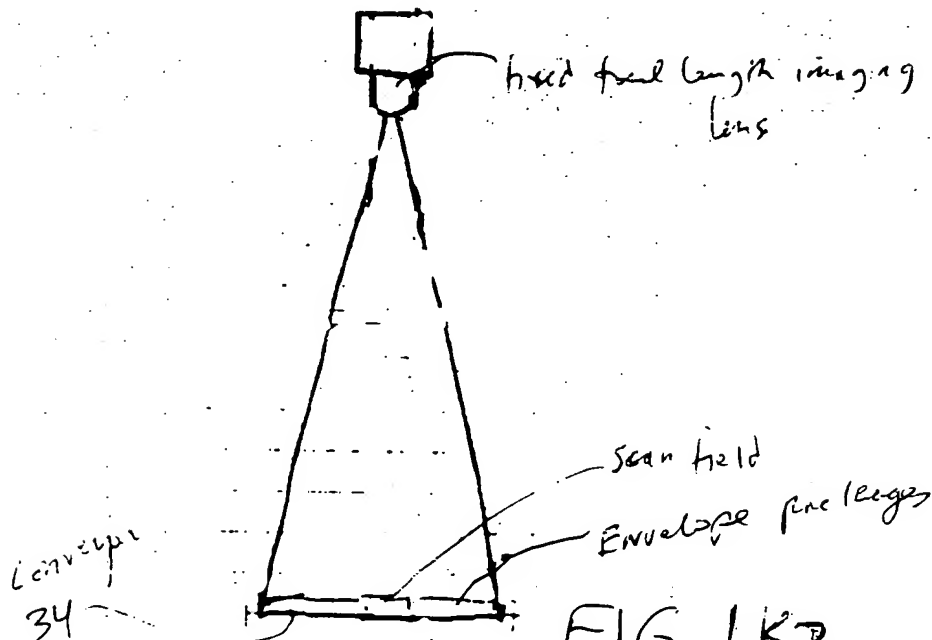


FIG 1K2  
converge 34

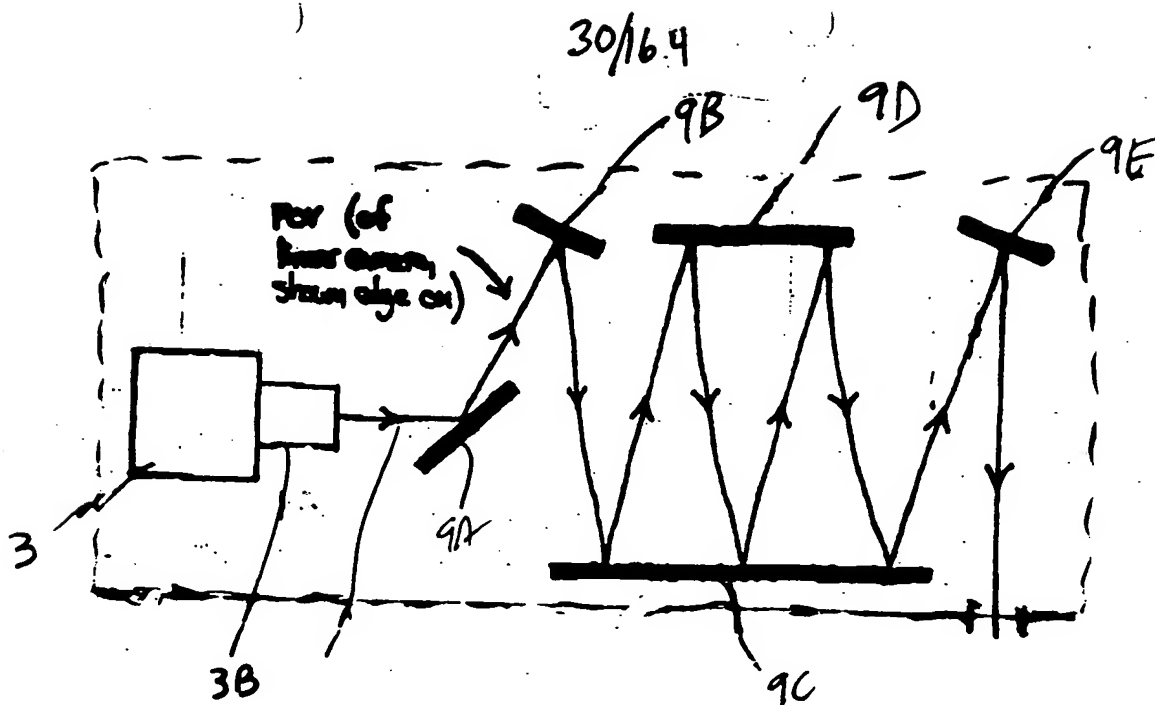


FIG. 1L1

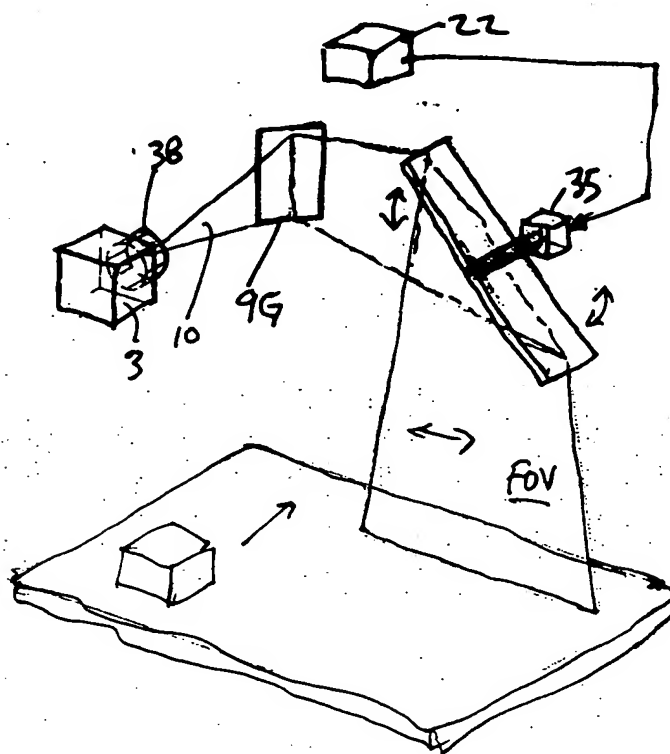


FIG. 1L2

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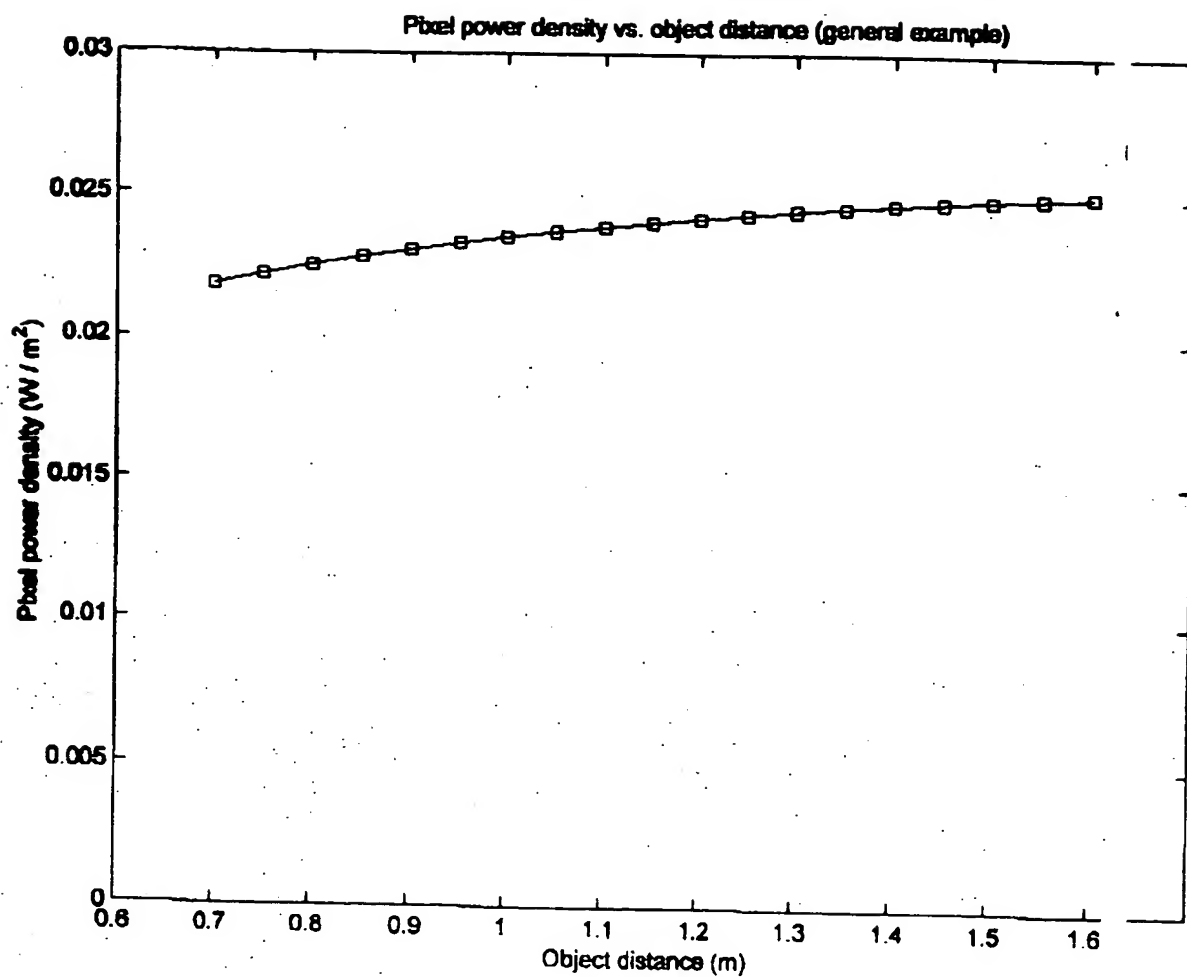


FIG-1M1

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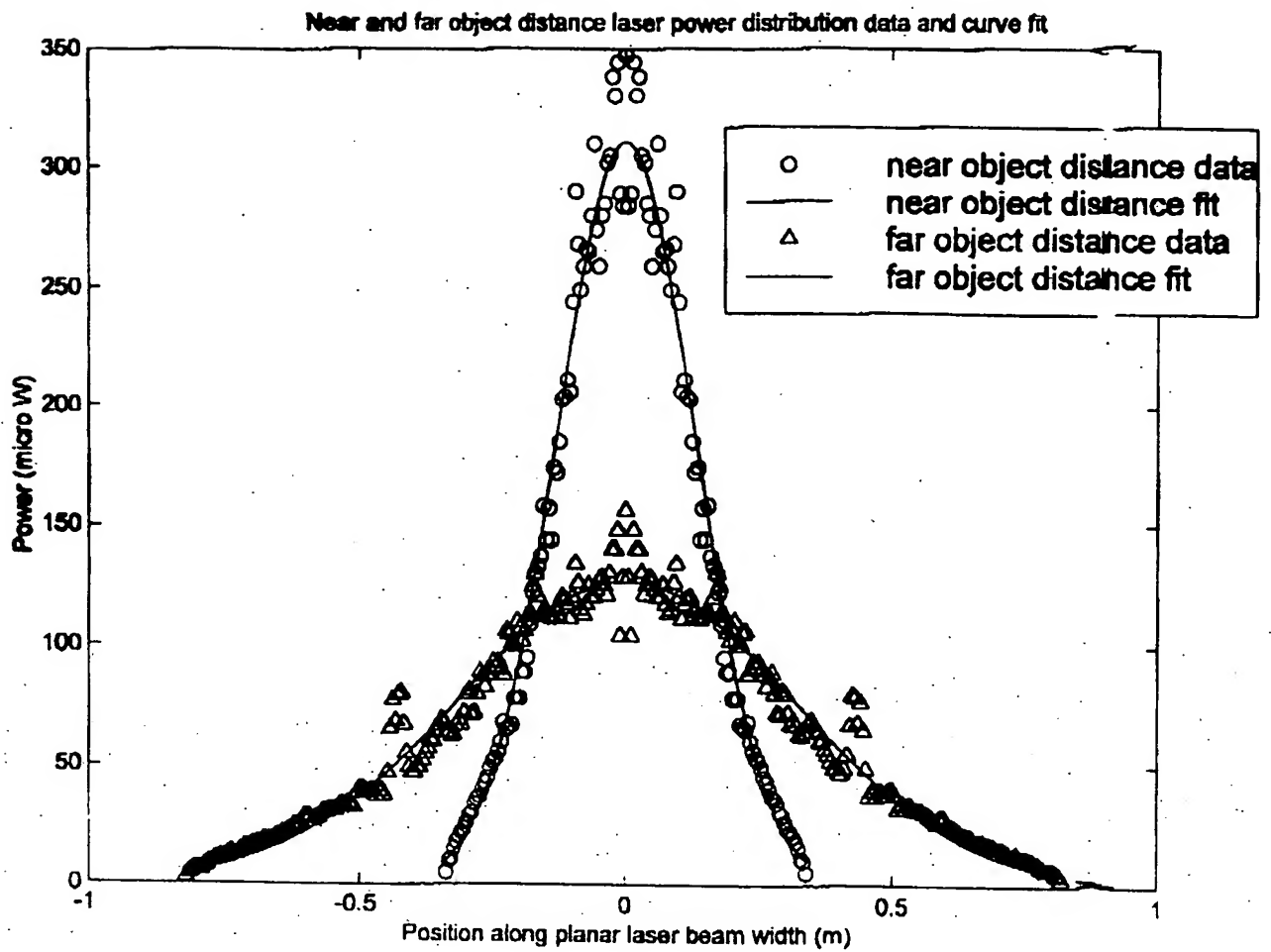


FIG. 1M2

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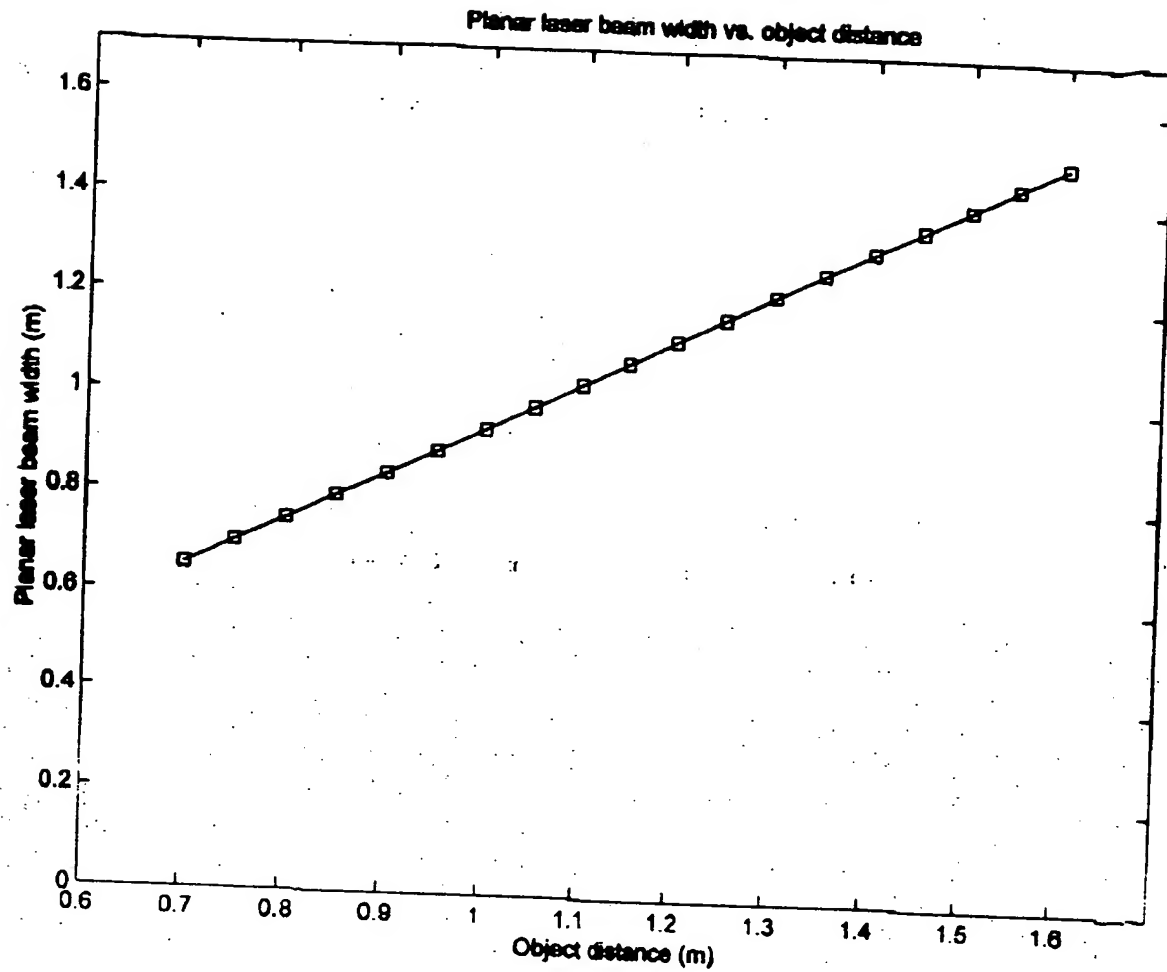


FIG. 1M3

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Figure 4: Planar laser beam height vs. object distance (far object distance focus)

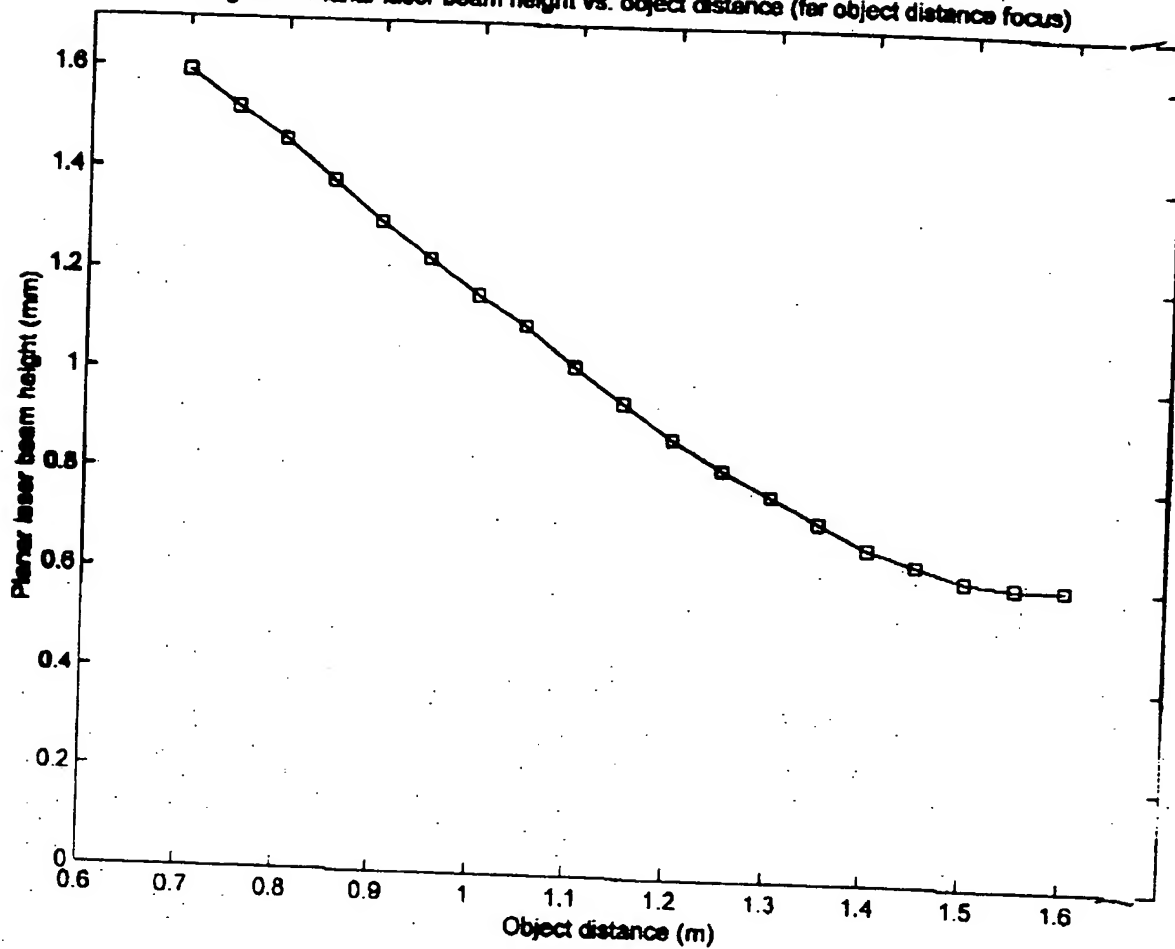


FIG 1M4

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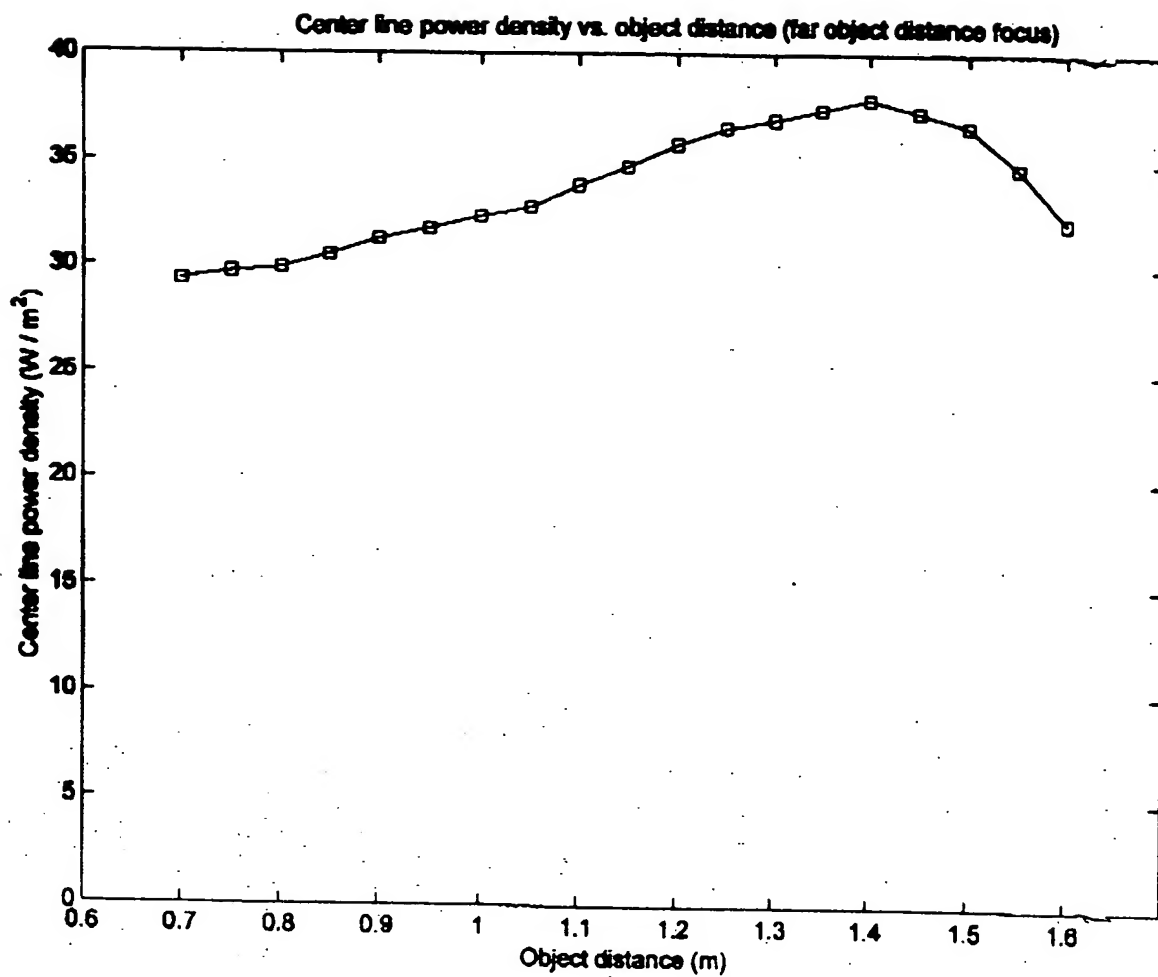


FIG. 1N

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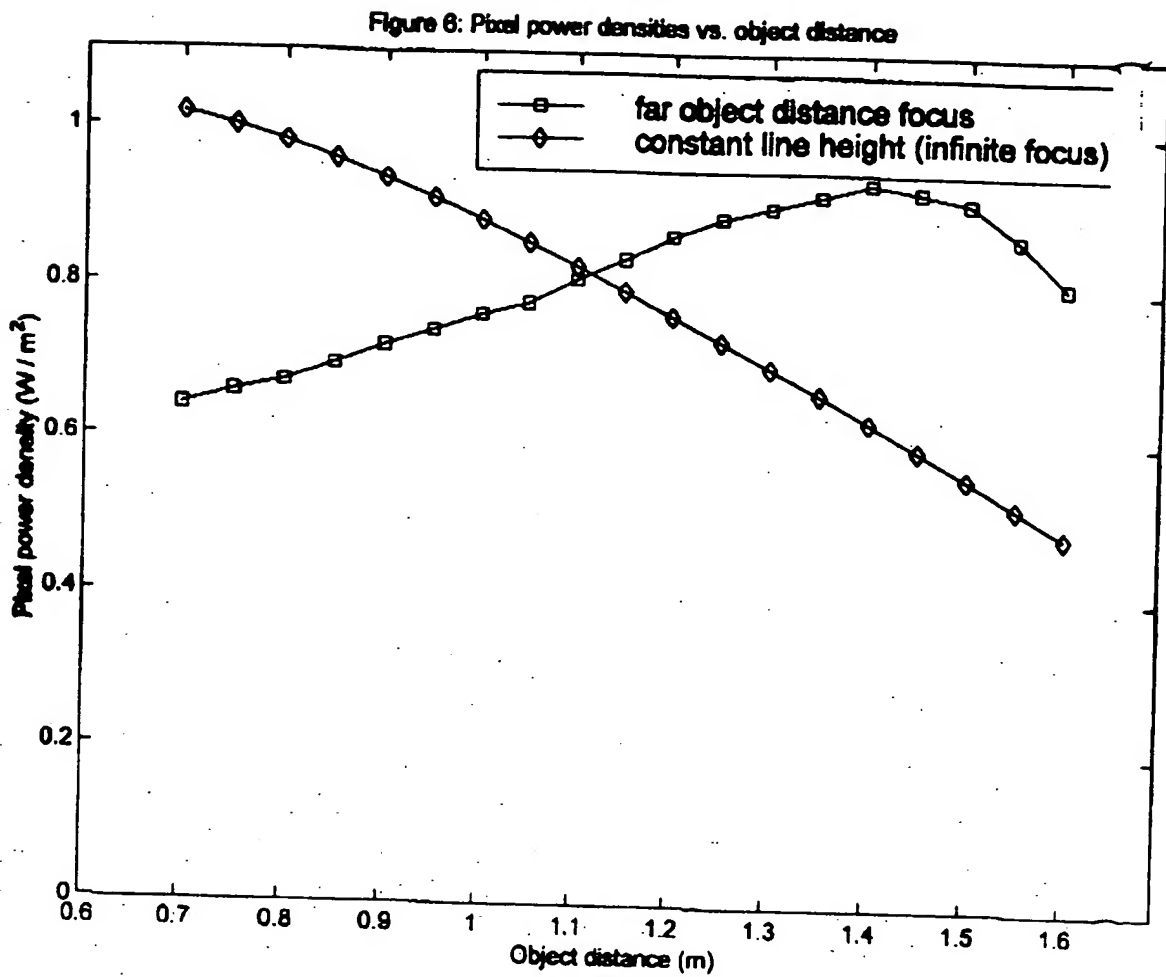


FIG. 10

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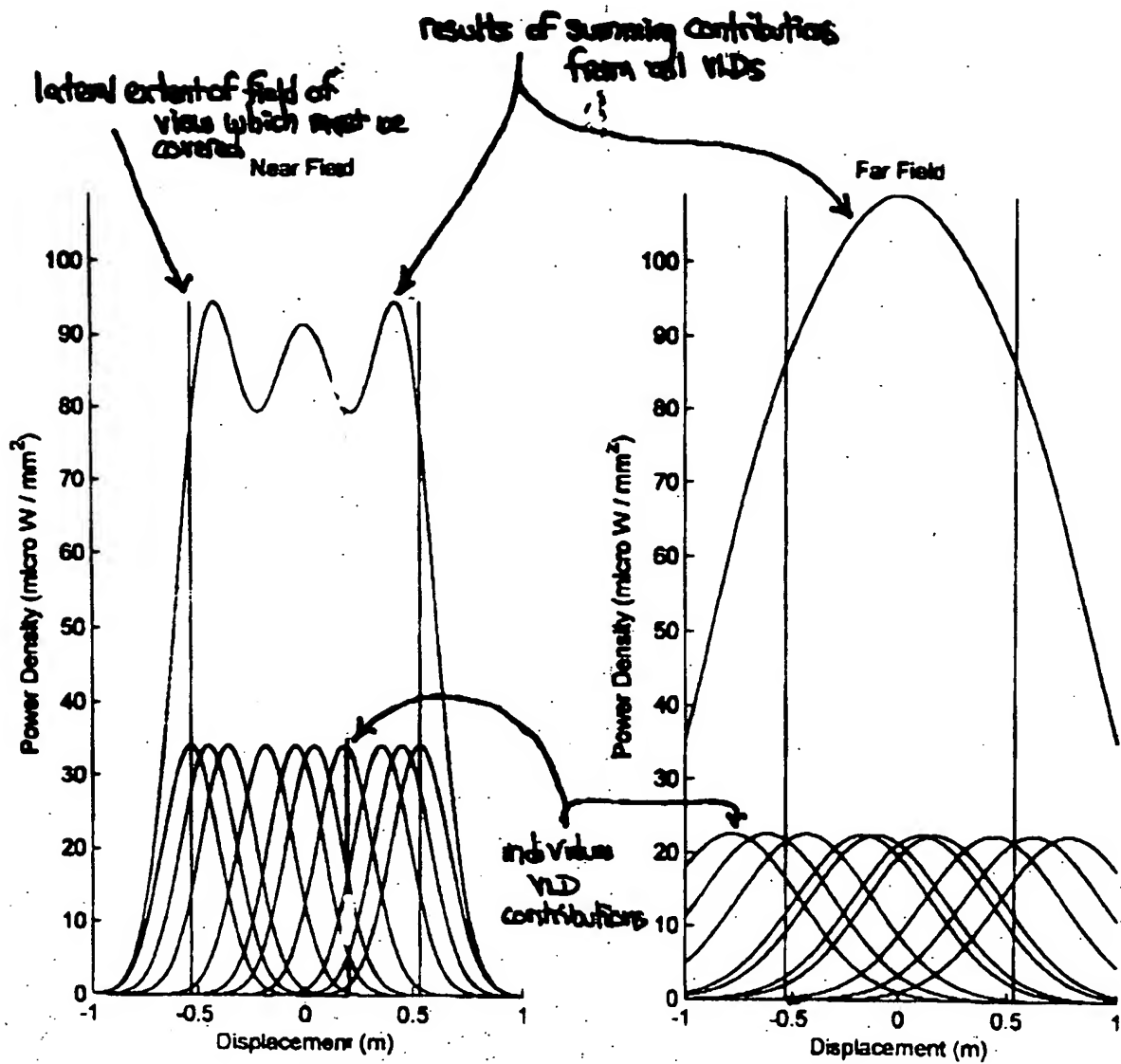


FIG 1P1

FIG 1P2

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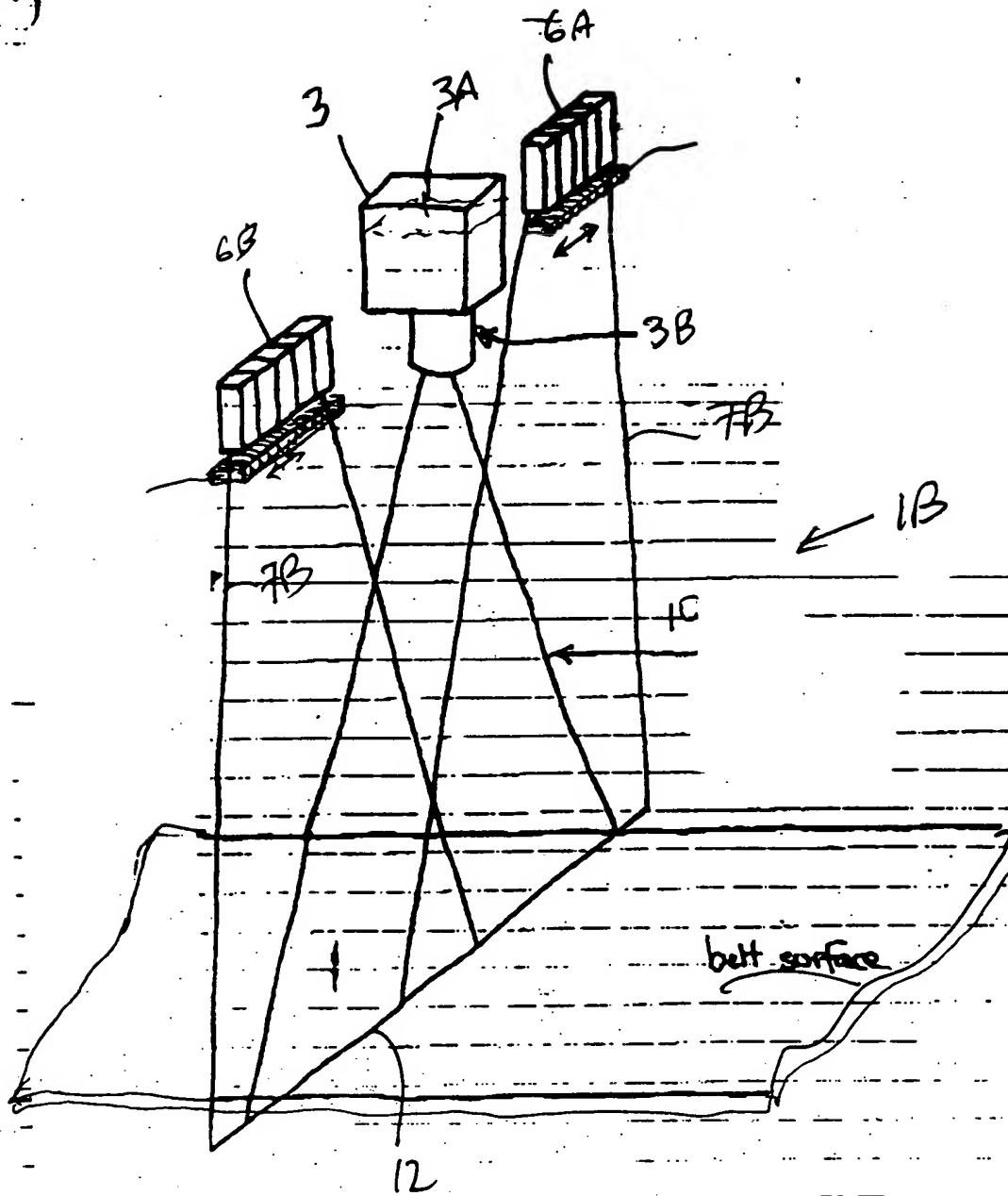


FIG. 1Q1

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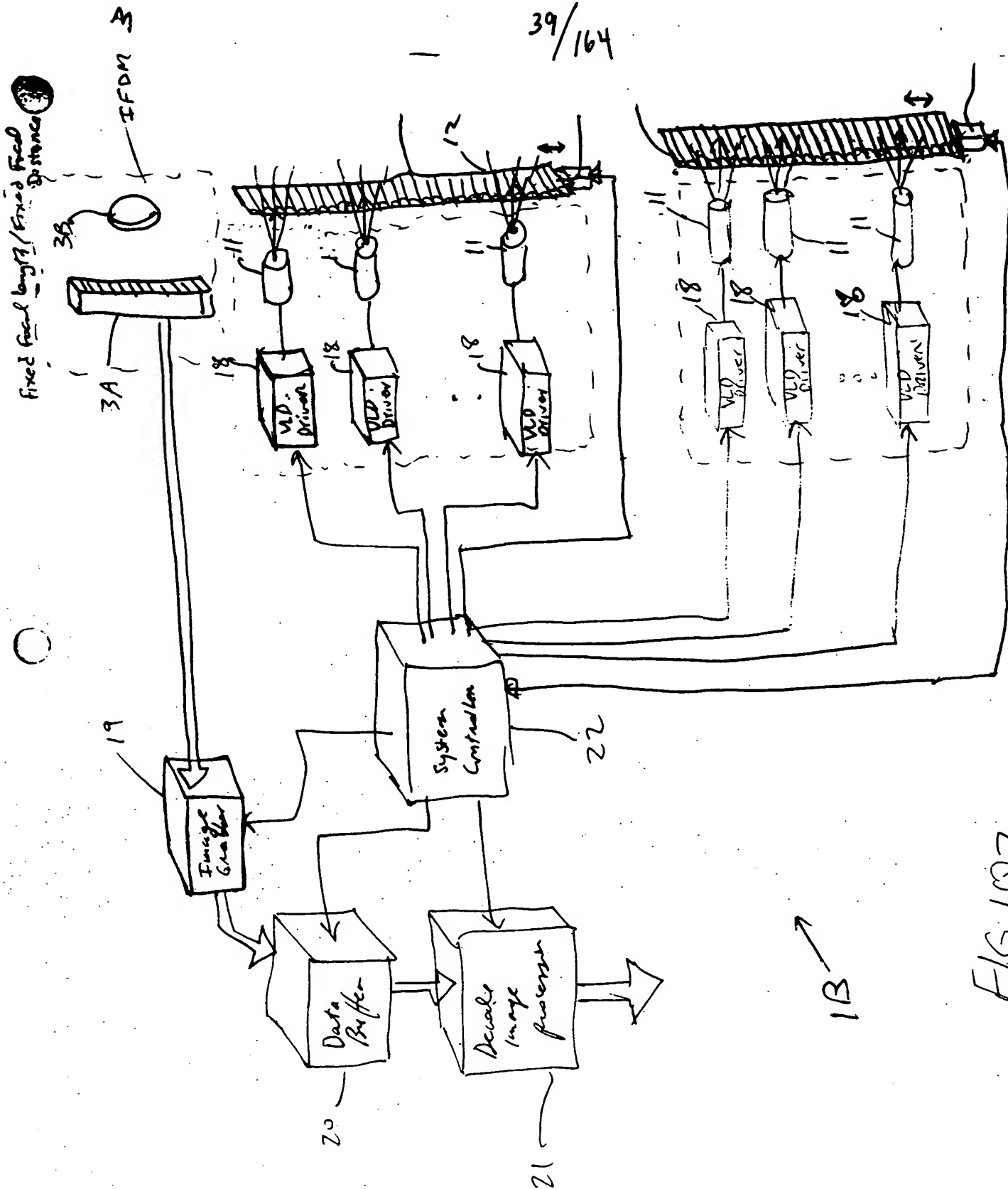


FIG. 102

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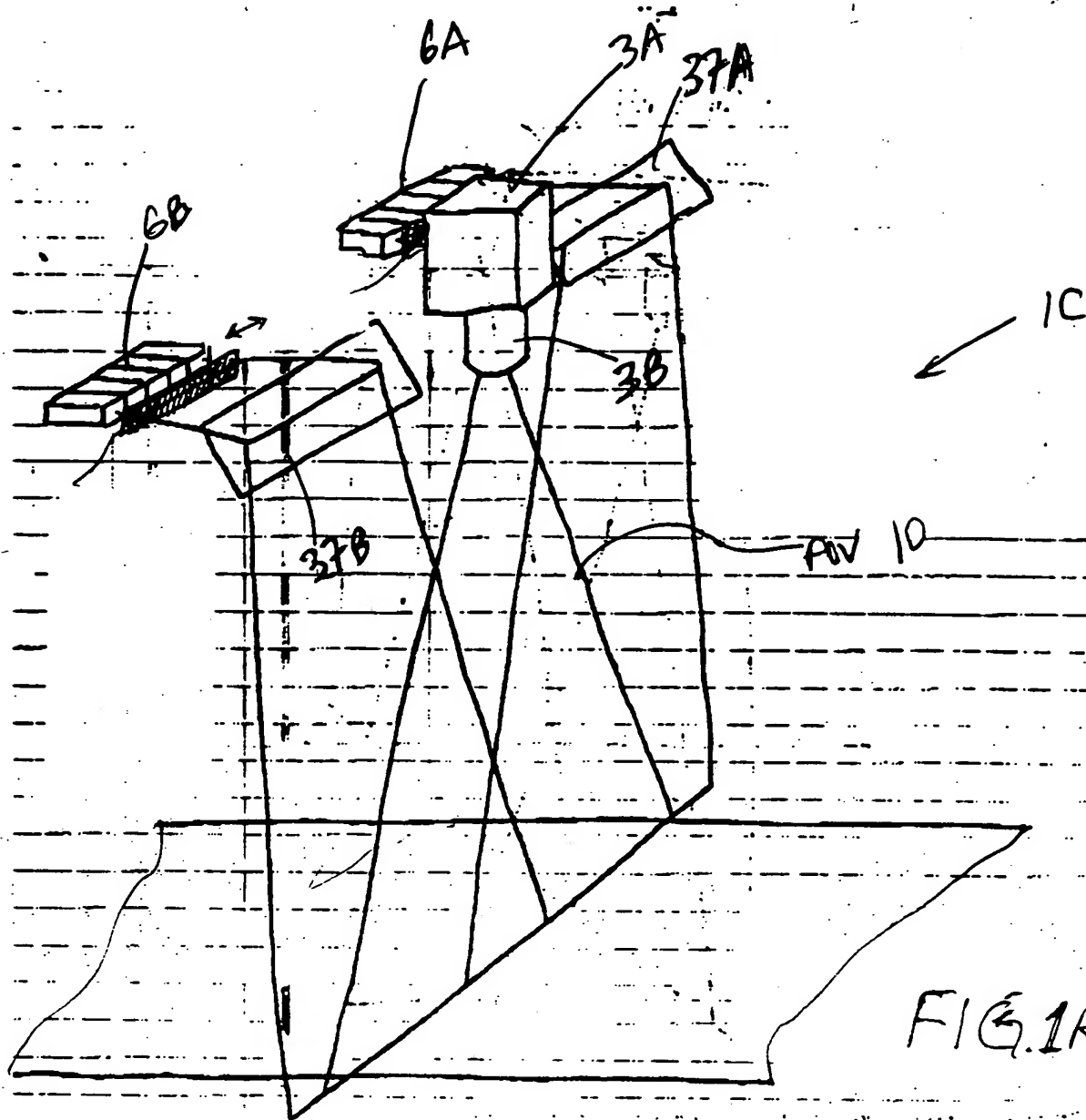


FIG. 1R1

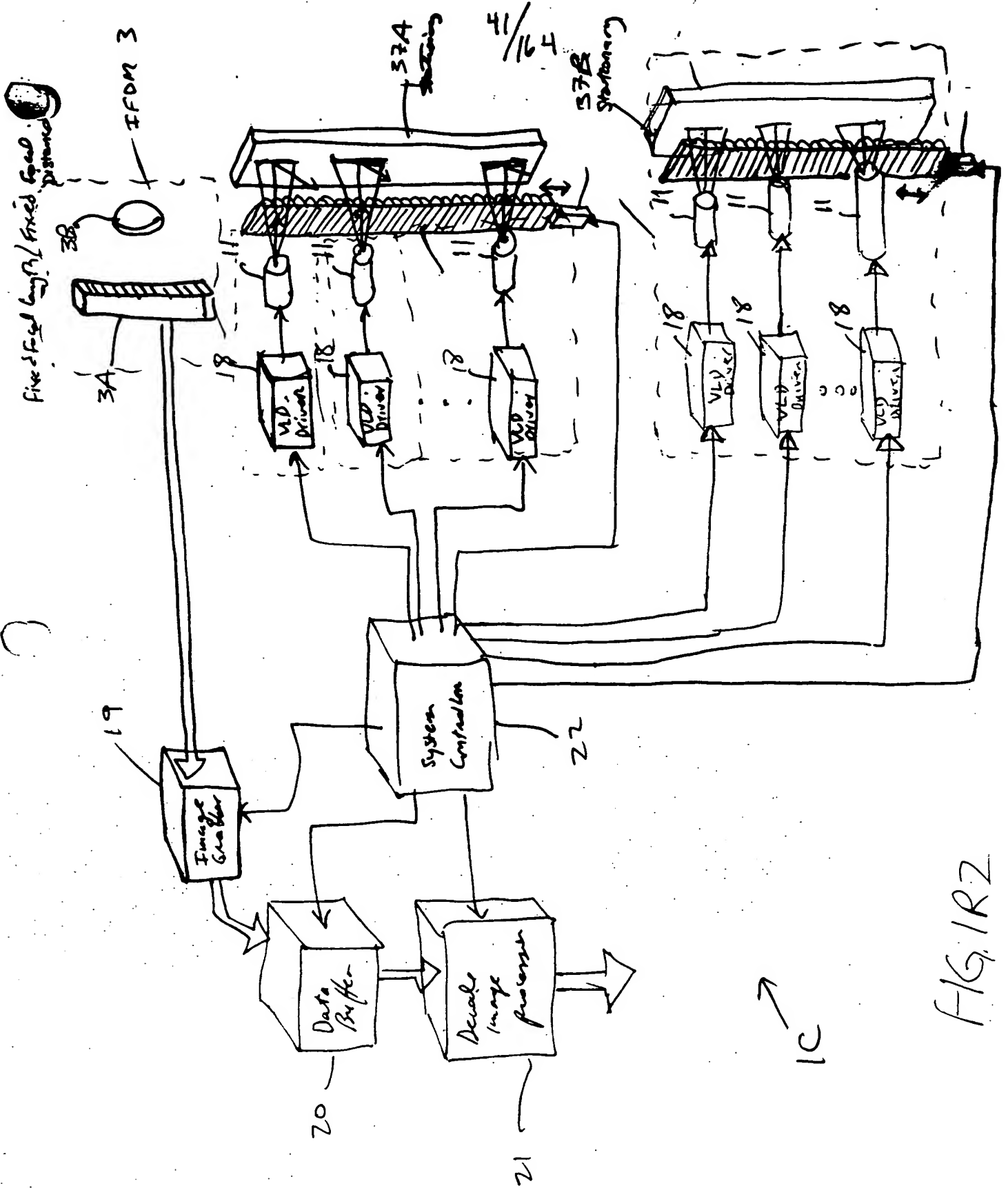


FIG. 1R2

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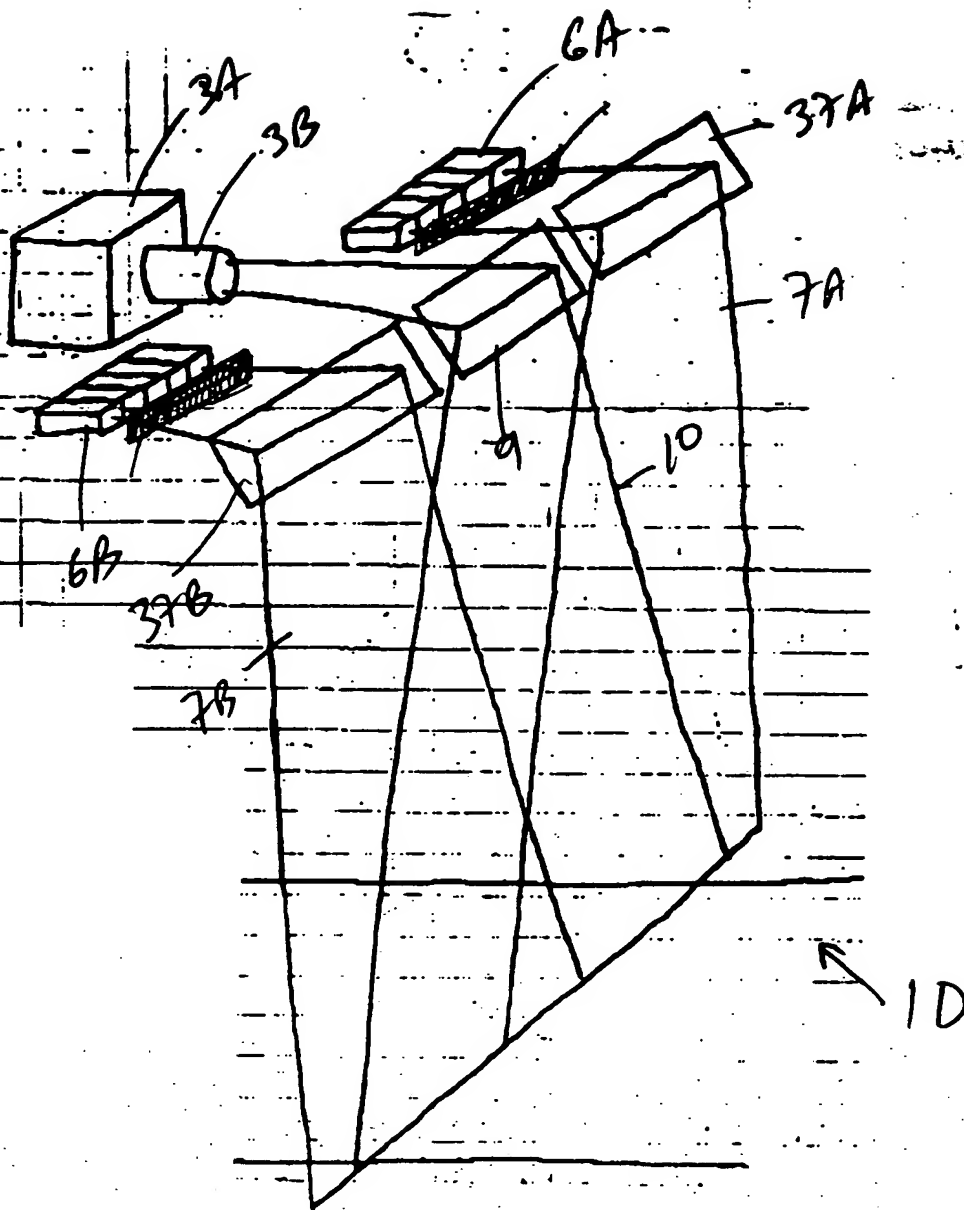
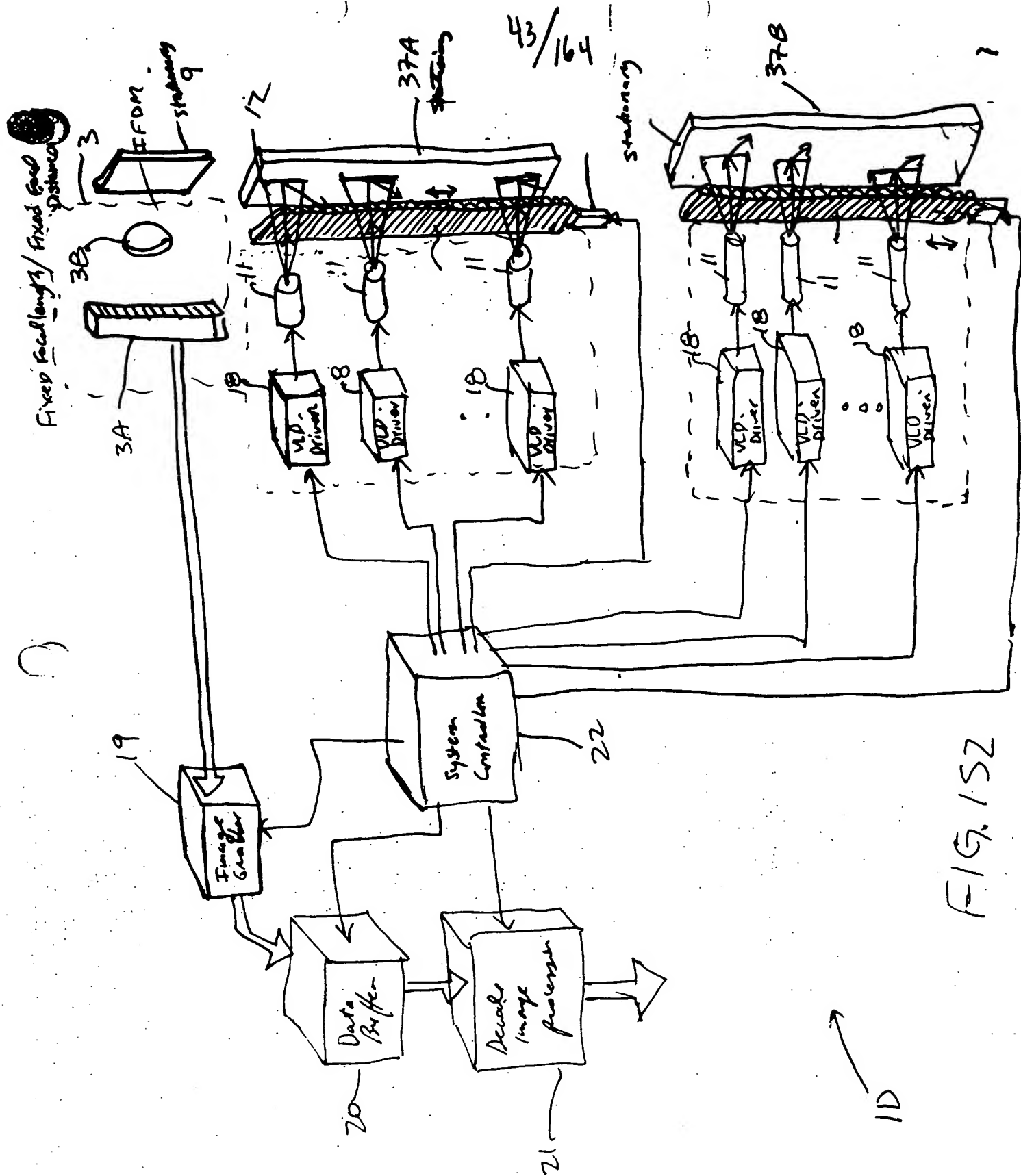


FIG. 1S1



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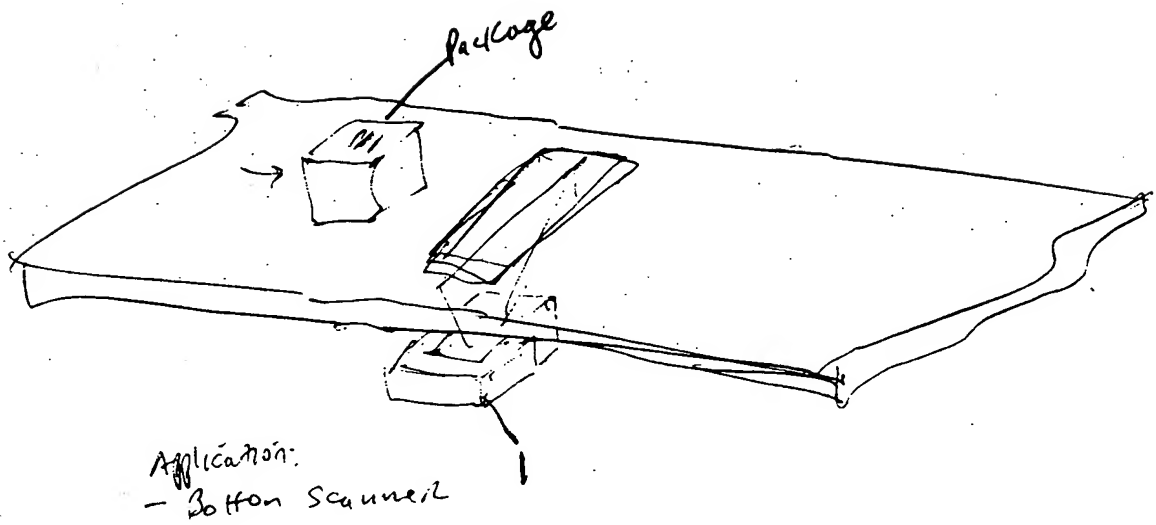


FIG 1T

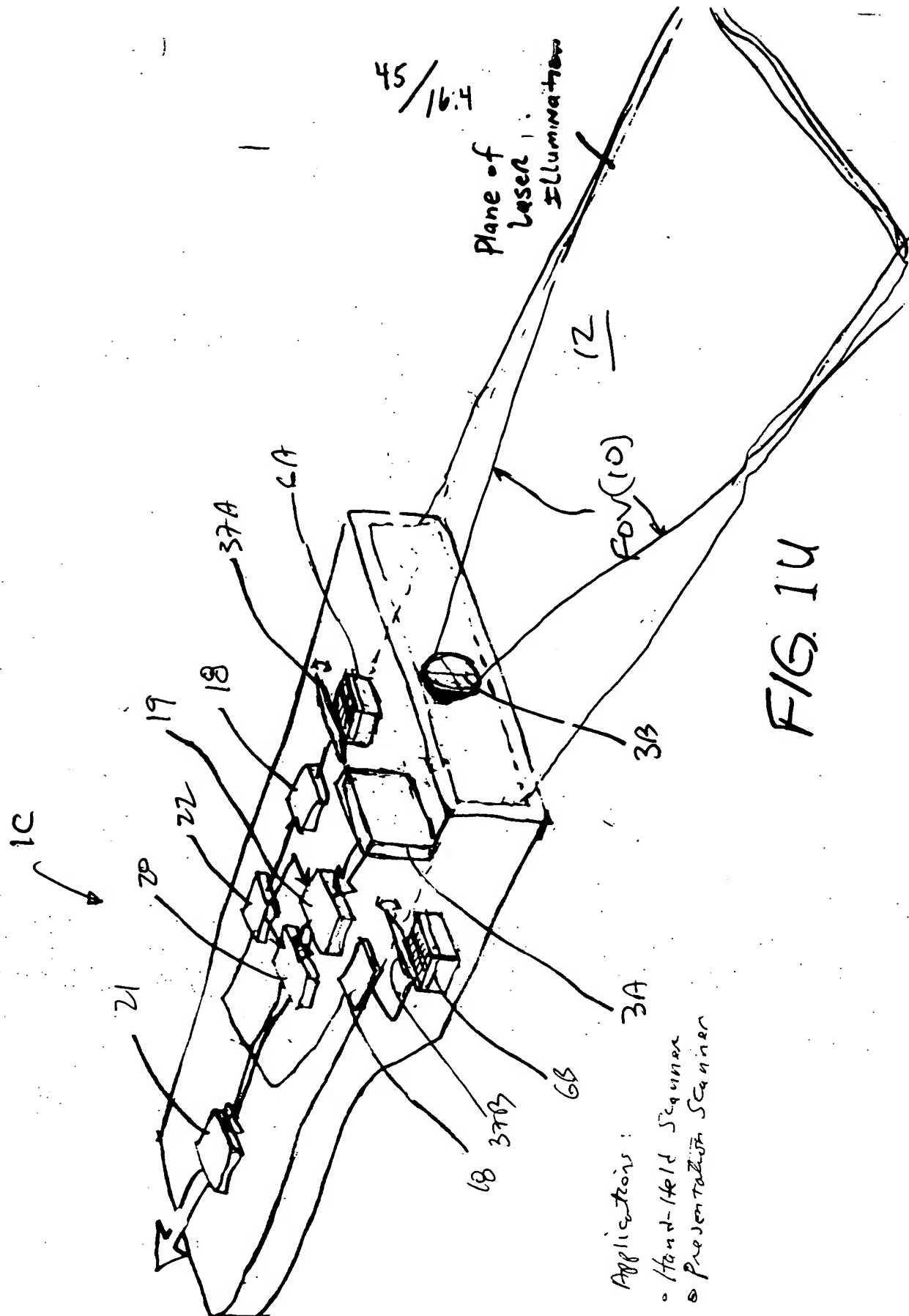


FIG. 14

Applications:

- Hand-Held Scanner
- Presentation Scanner

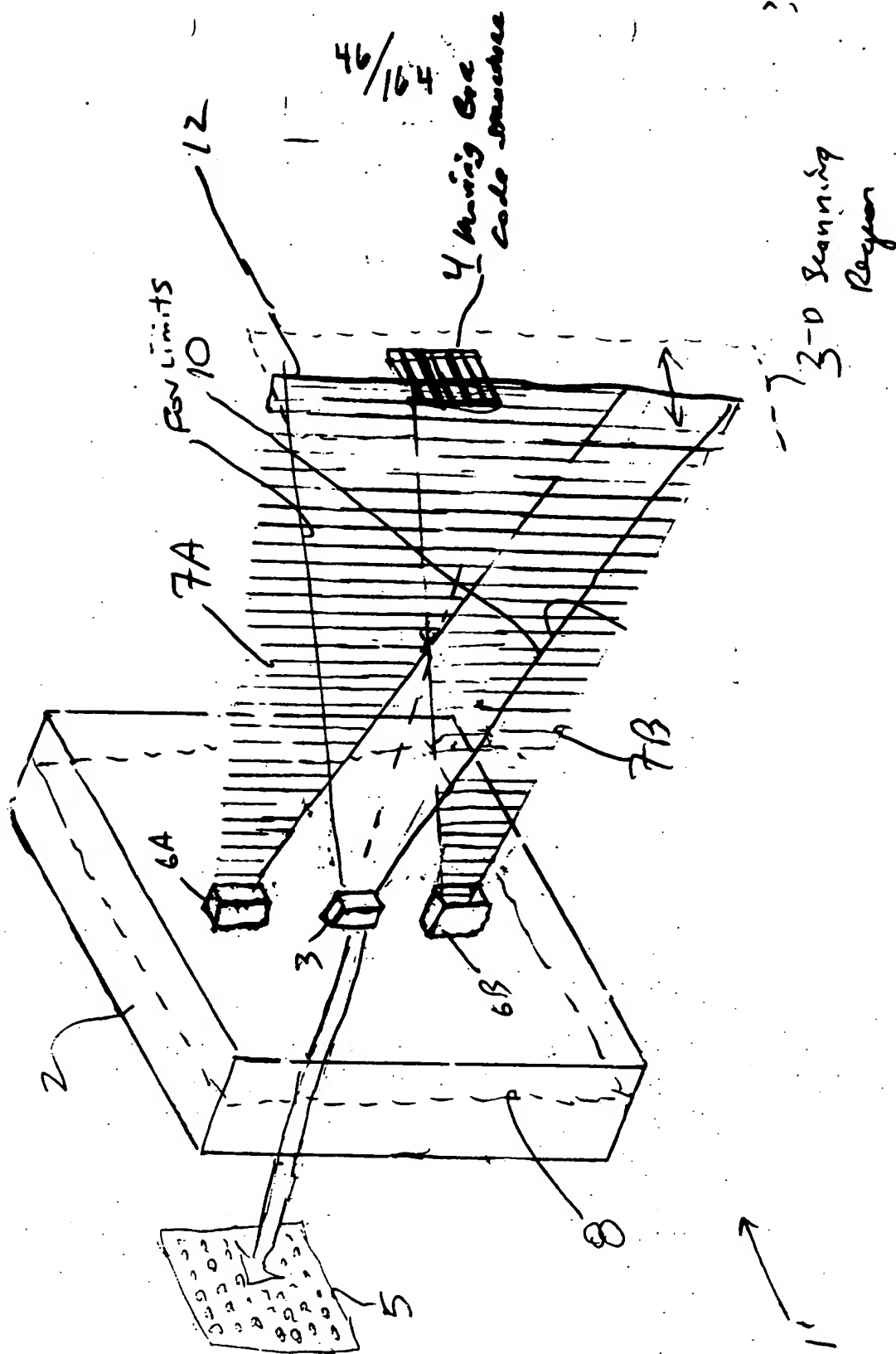


FIG. 1VI

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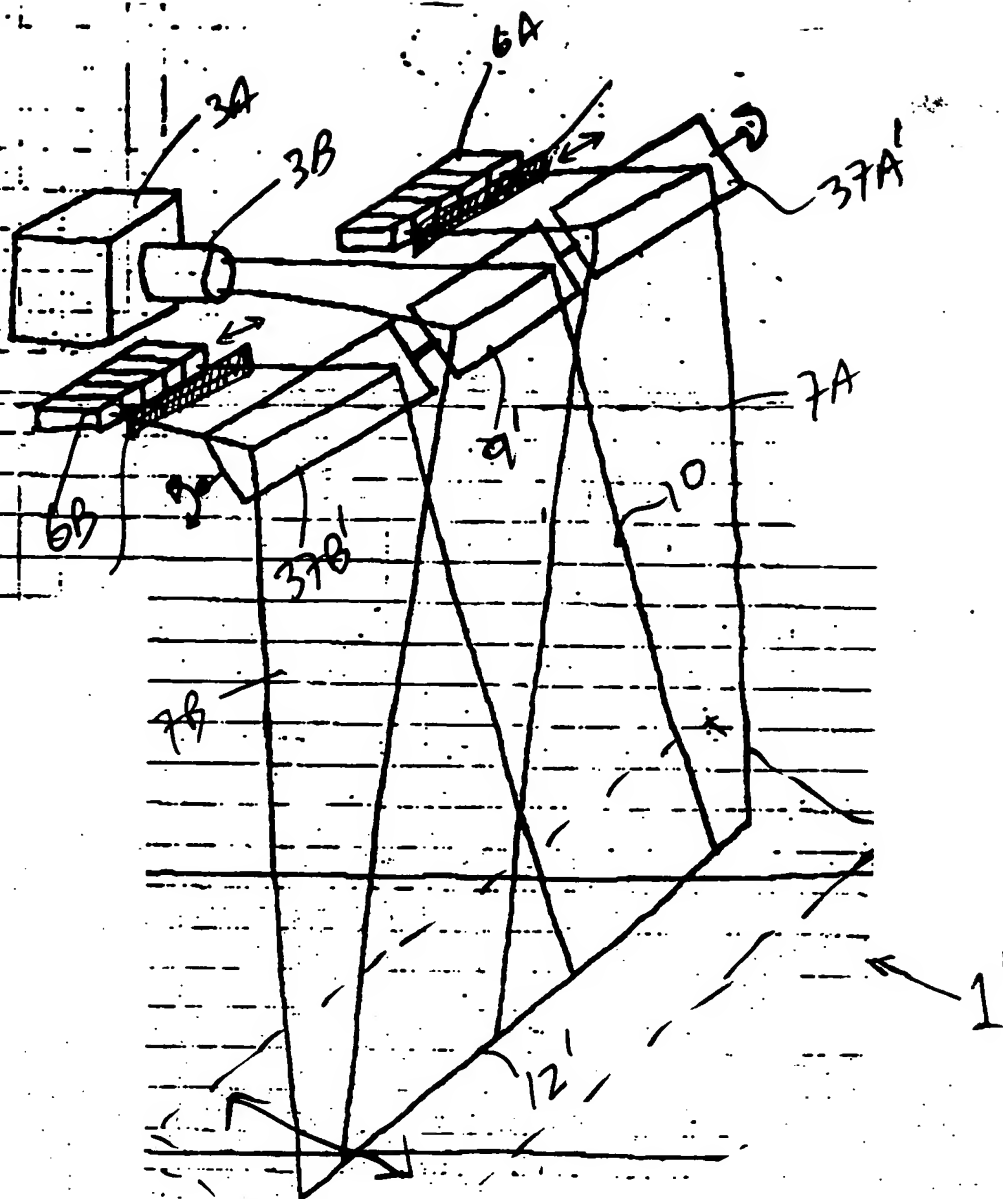
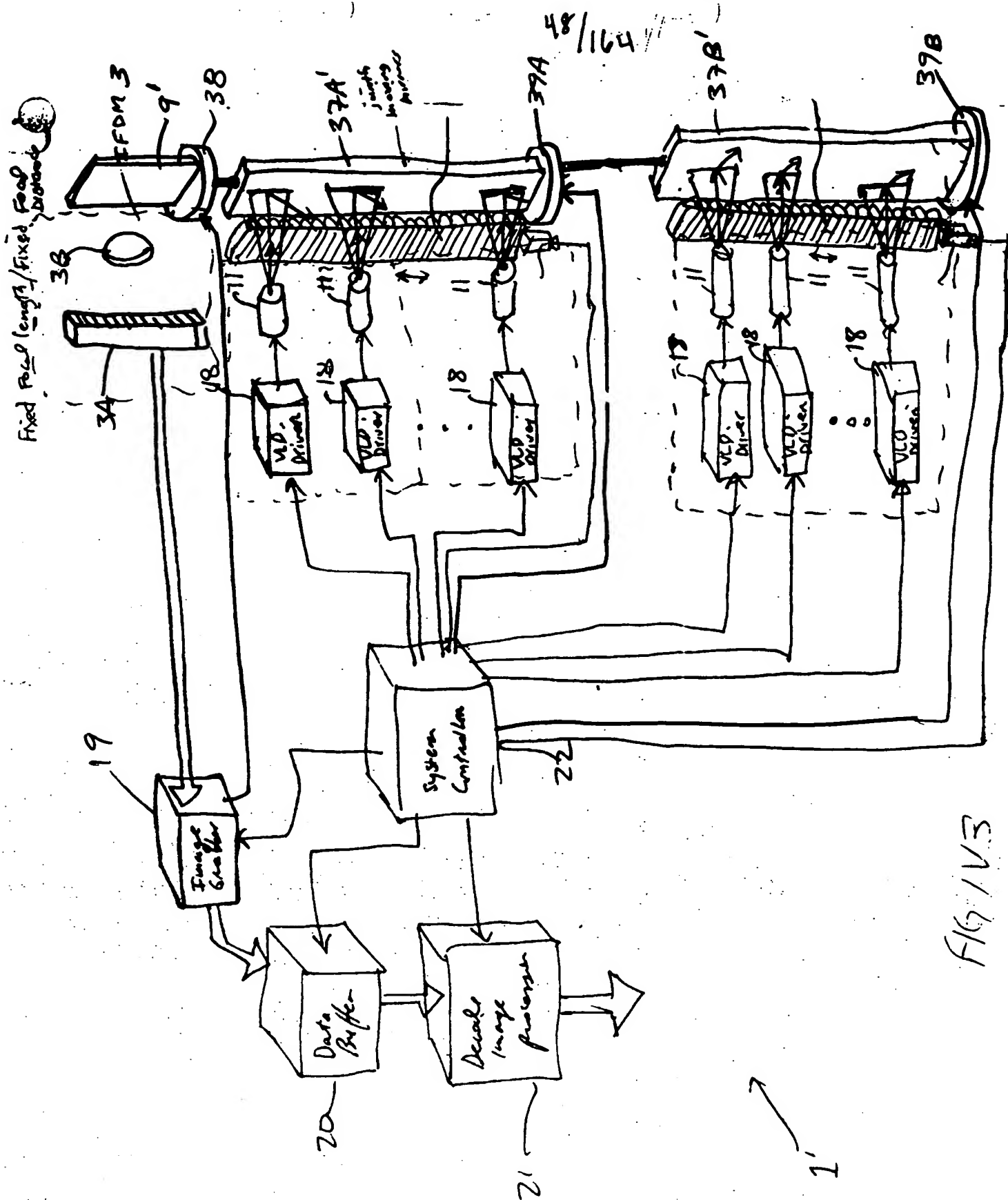


FIG. IV2

2-D  
region  
of  
space



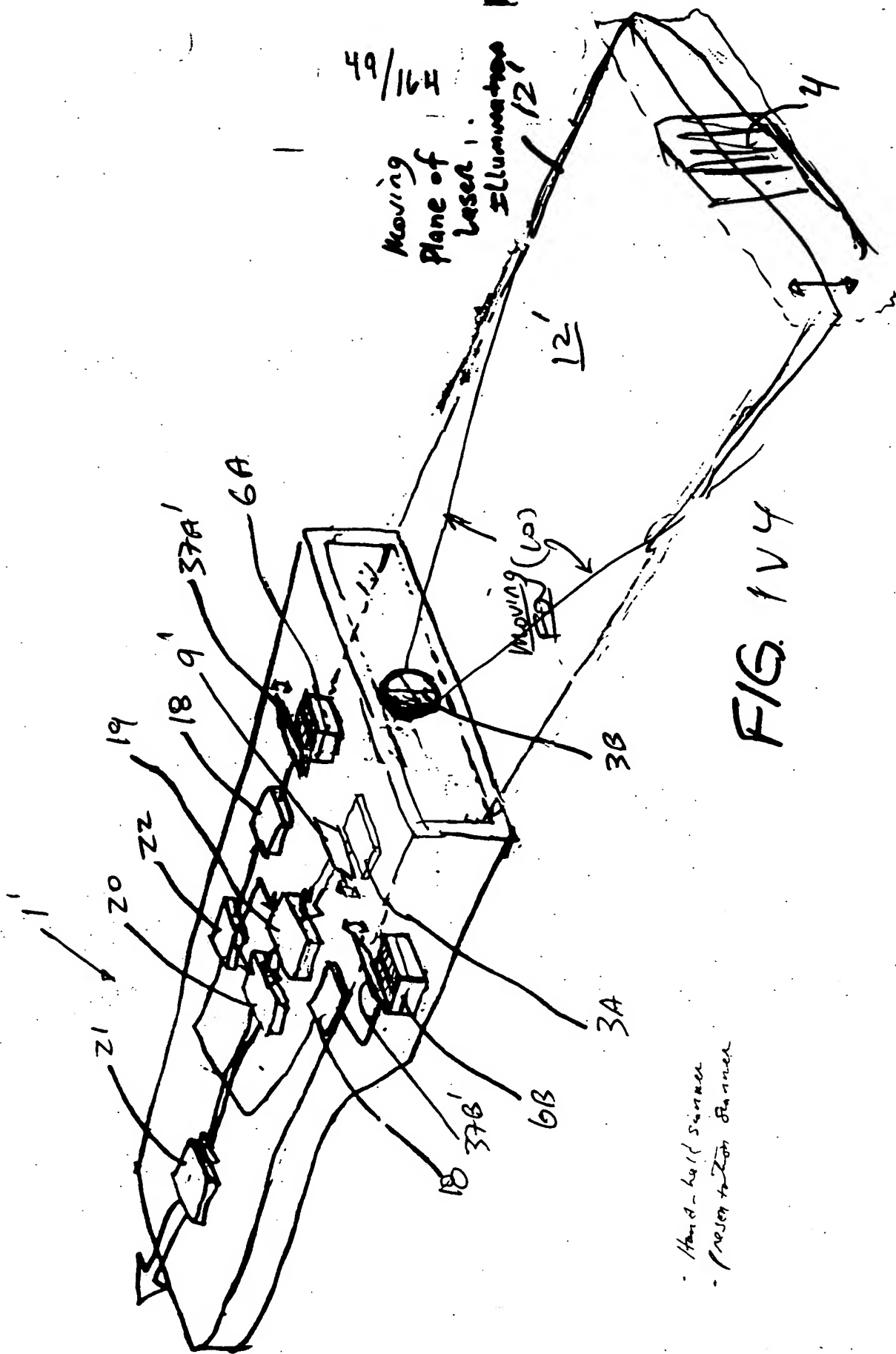
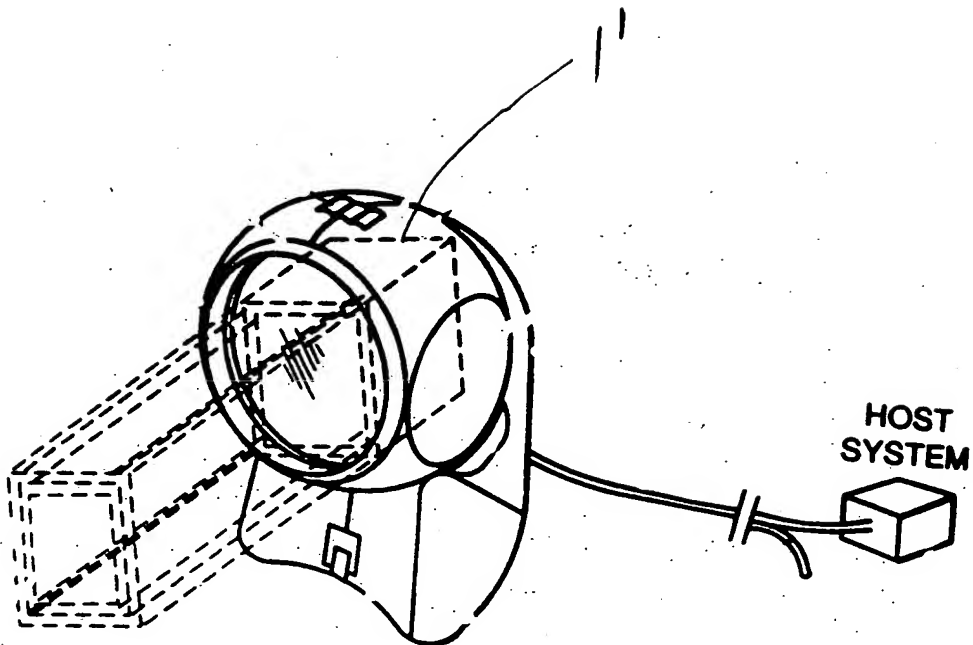


FIG. 1V4

Hand-held signaller  
- Preson to Zon Banner

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(Presentation type scanner)

FIG. 1V5

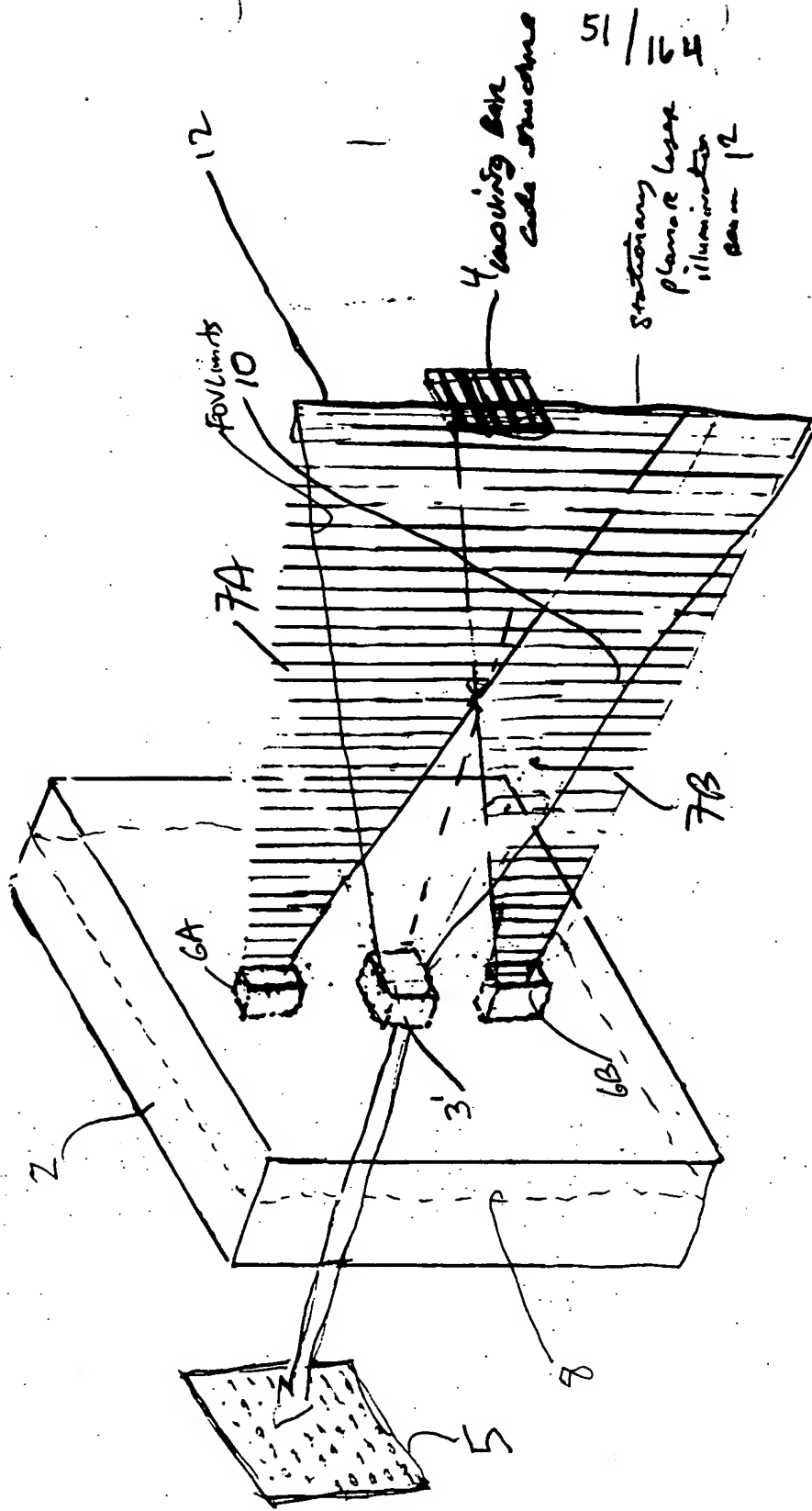


FIG. 2A

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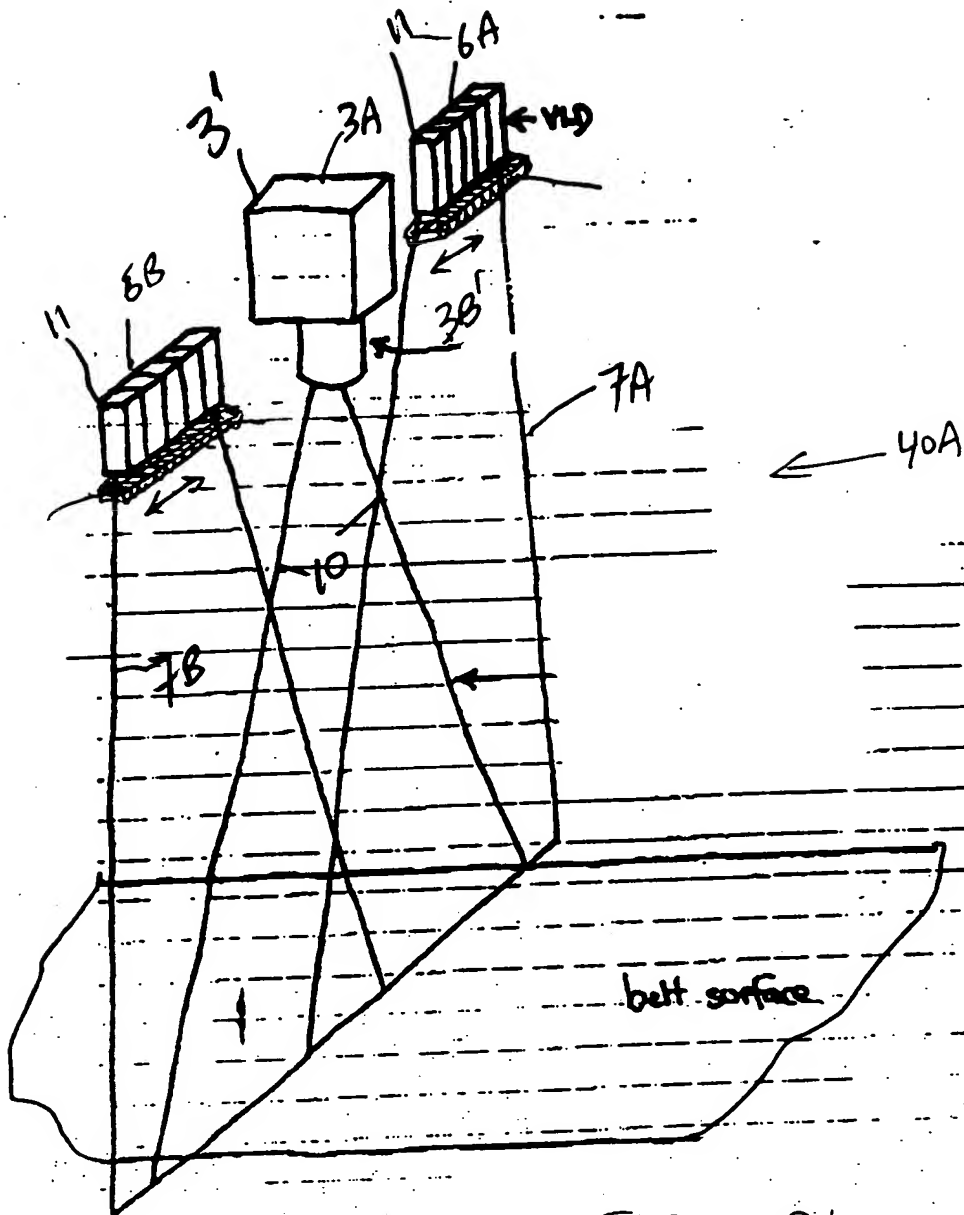
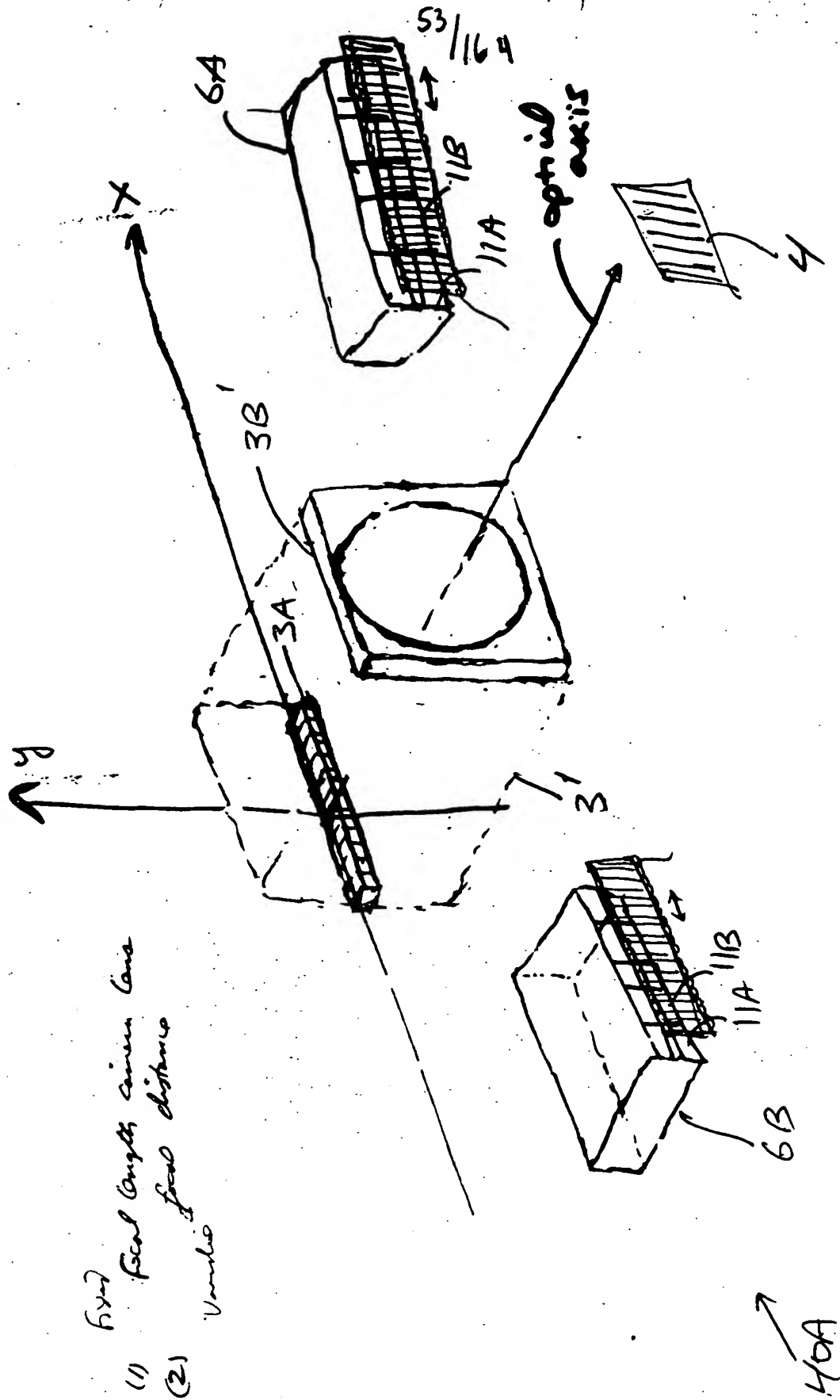


FIG. 2 B1



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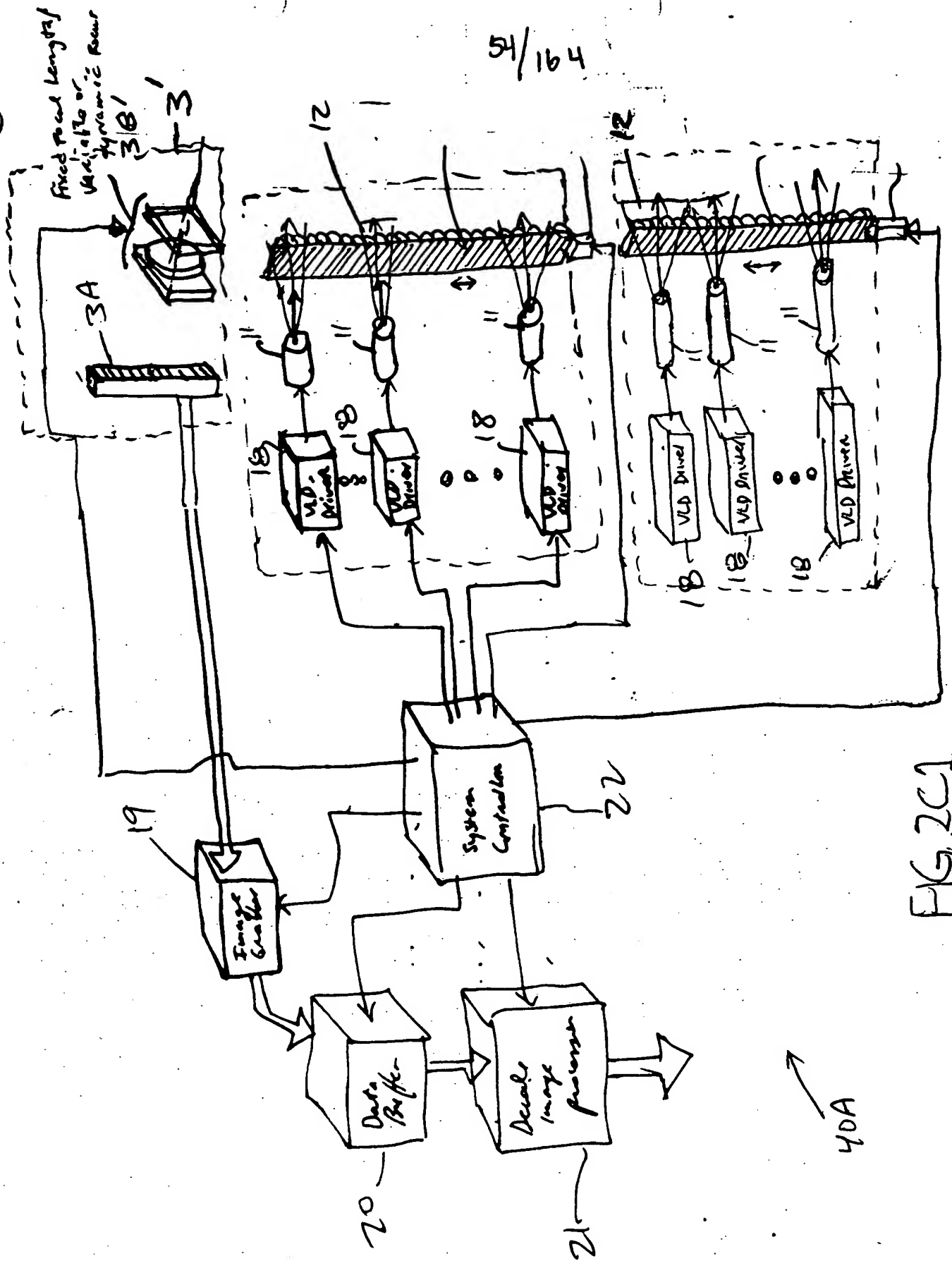


FIG. 2C1

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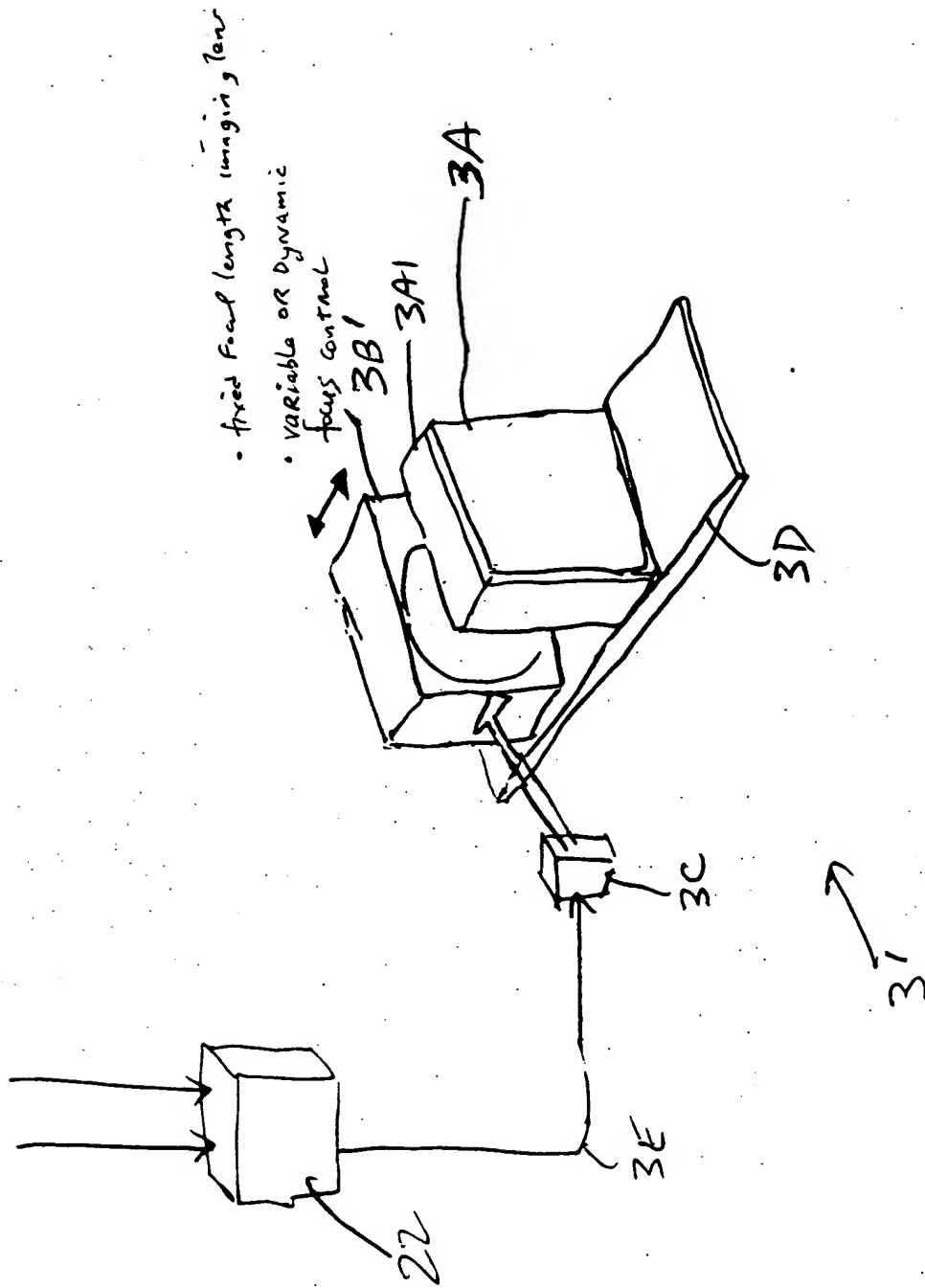


FIG. 2C2

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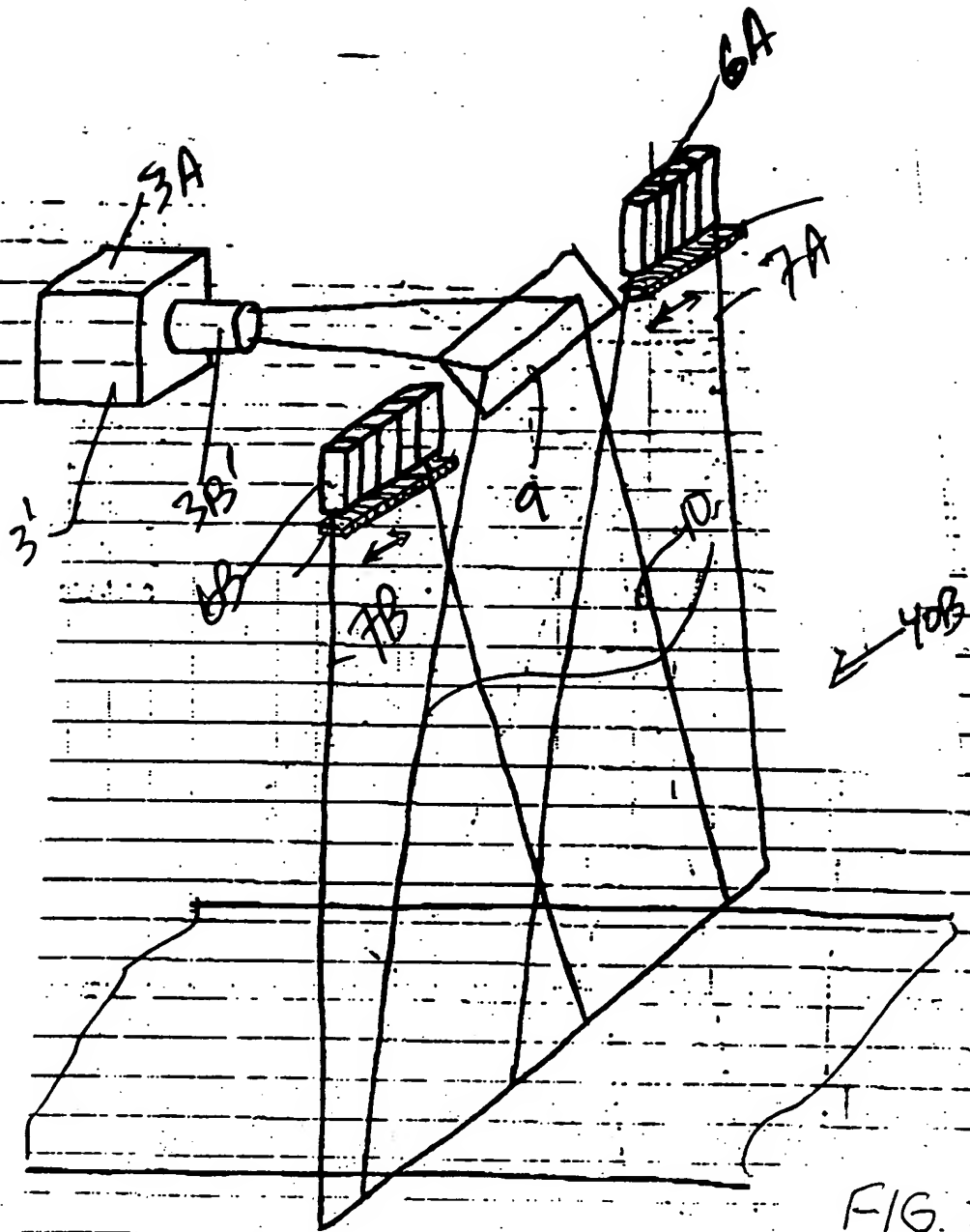
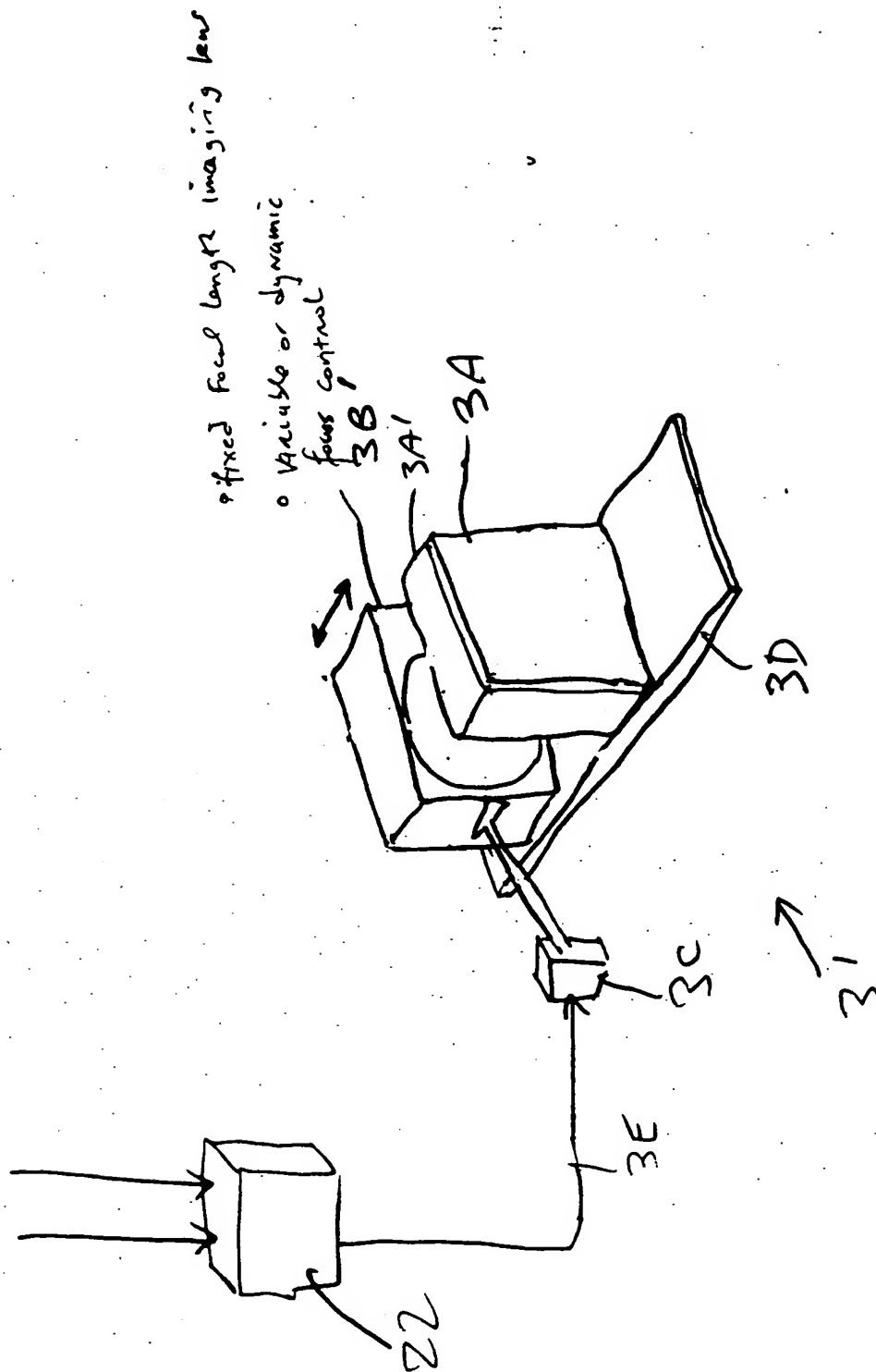


FIG. 2D1



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fixed focal length imaging lens

• variable or dynamic  
focus control

FIG. 2D3

FIG. 2E1

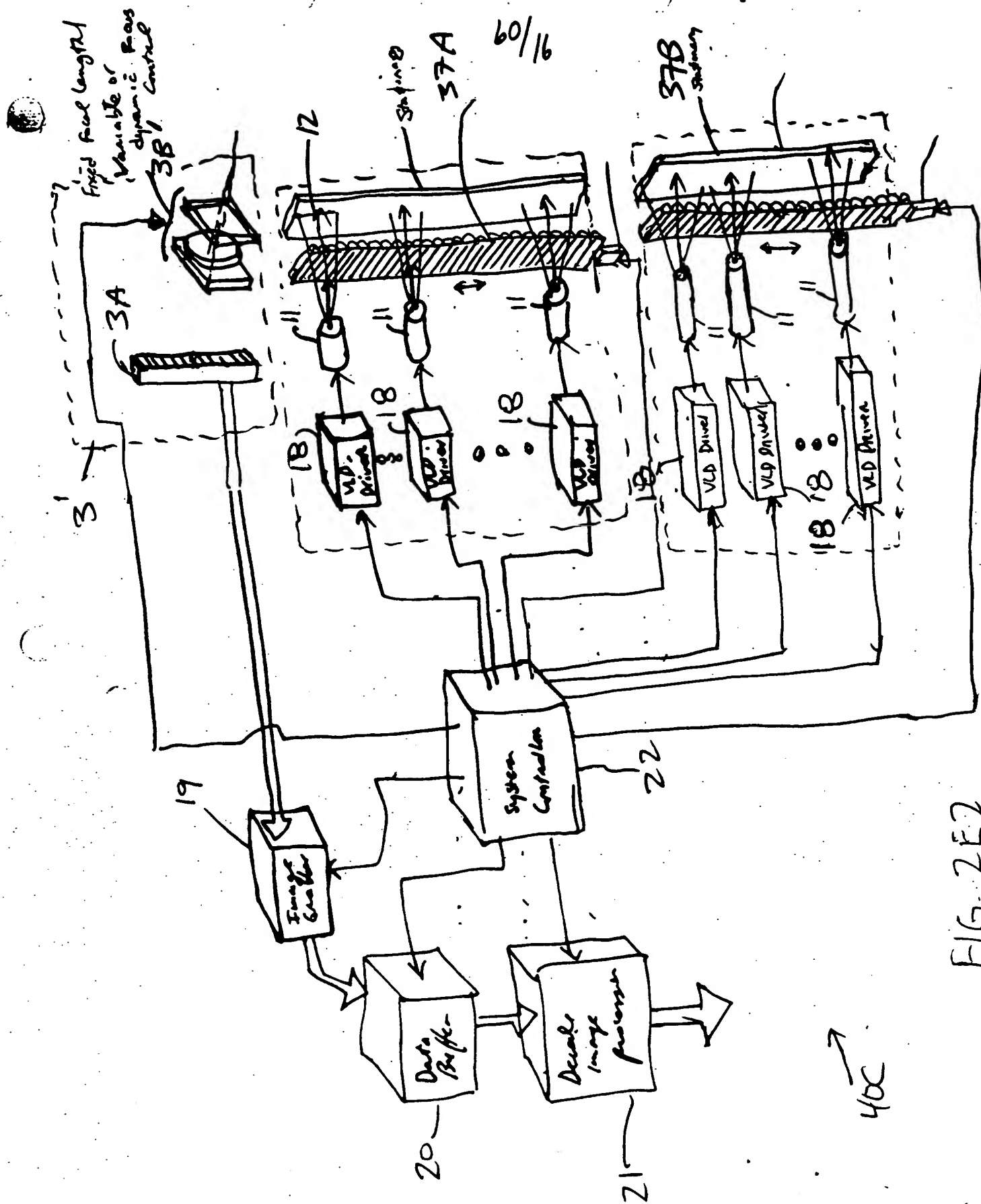


Fig. 2E2

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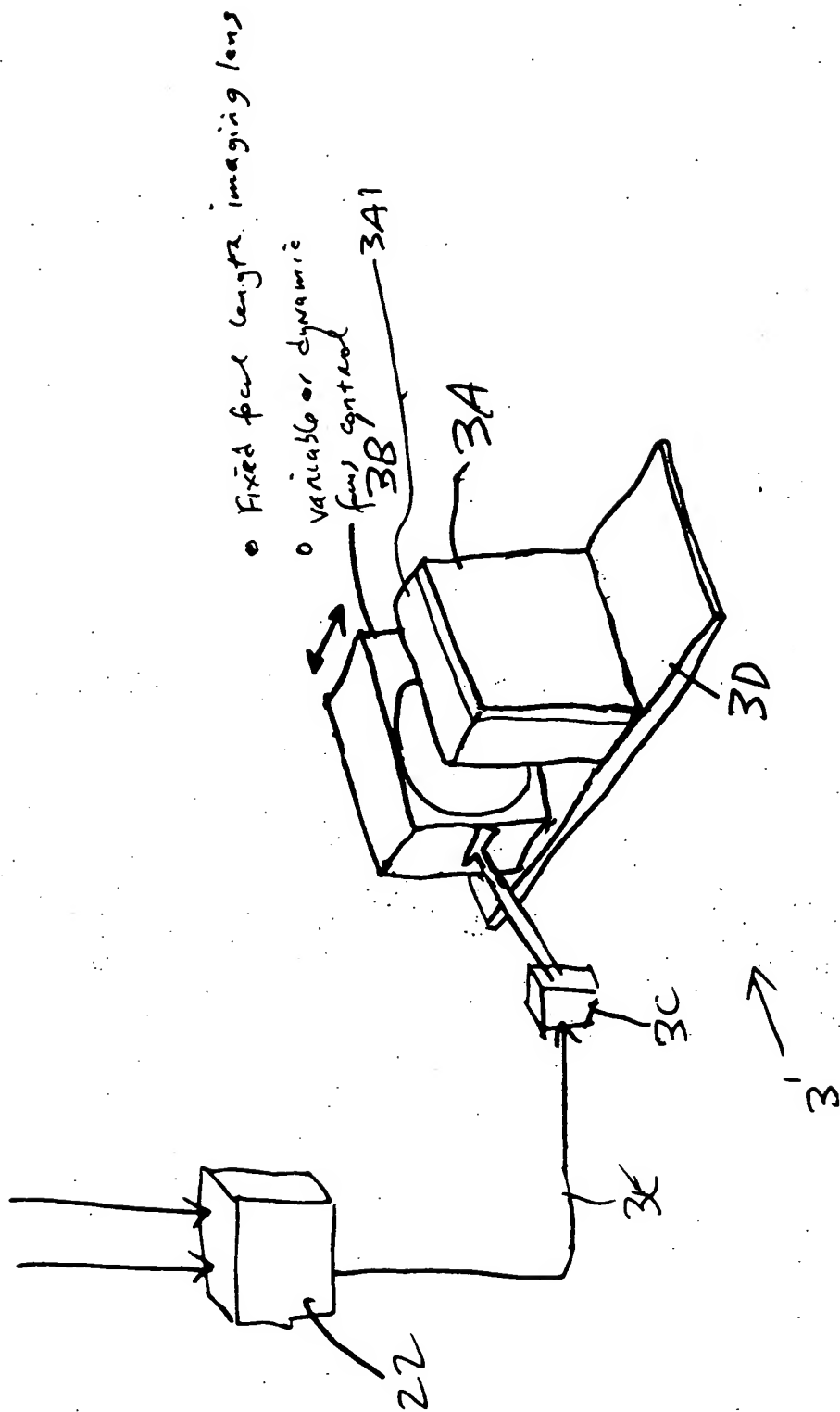


FIG. 2E3

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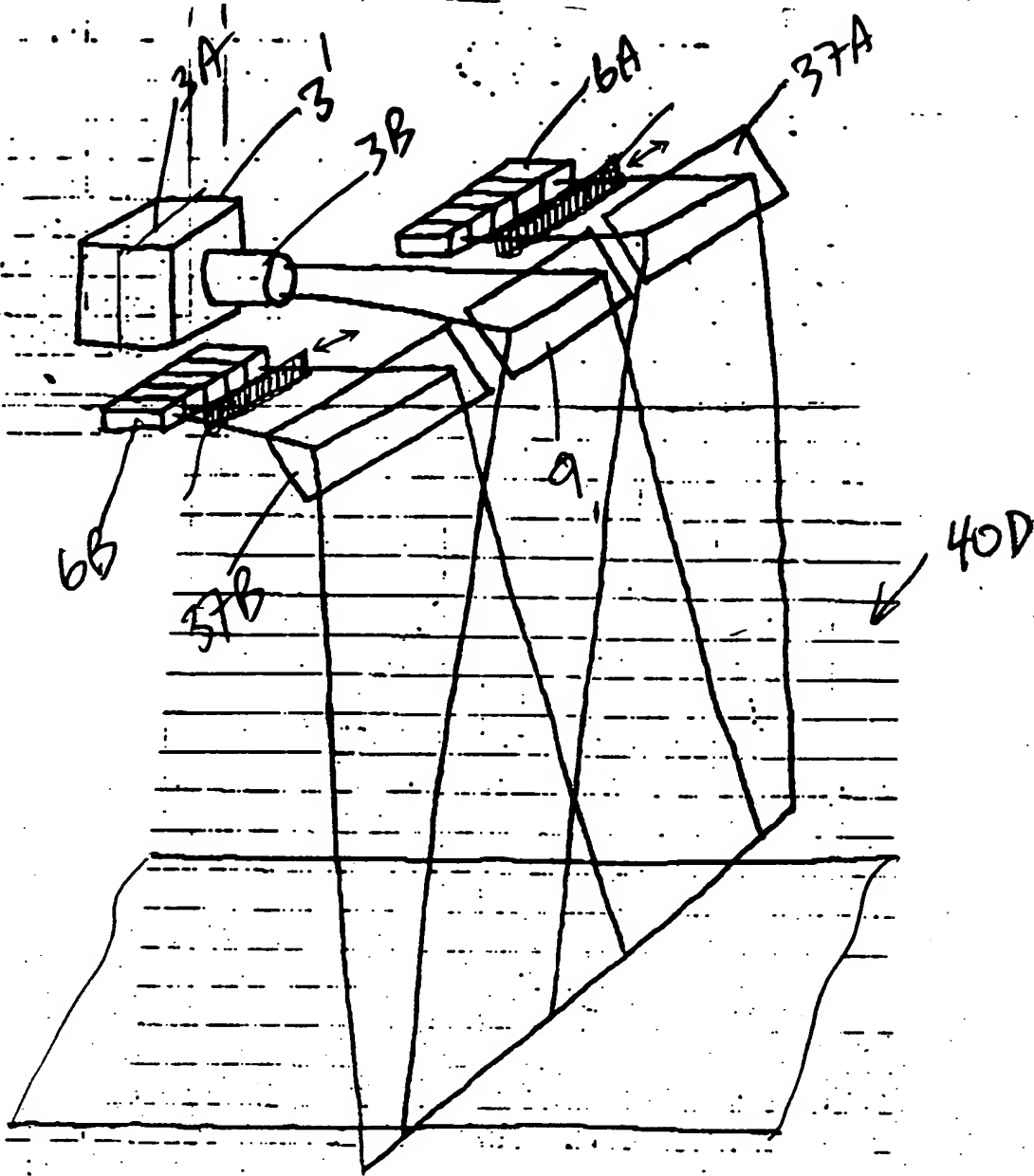


FIG 2F1

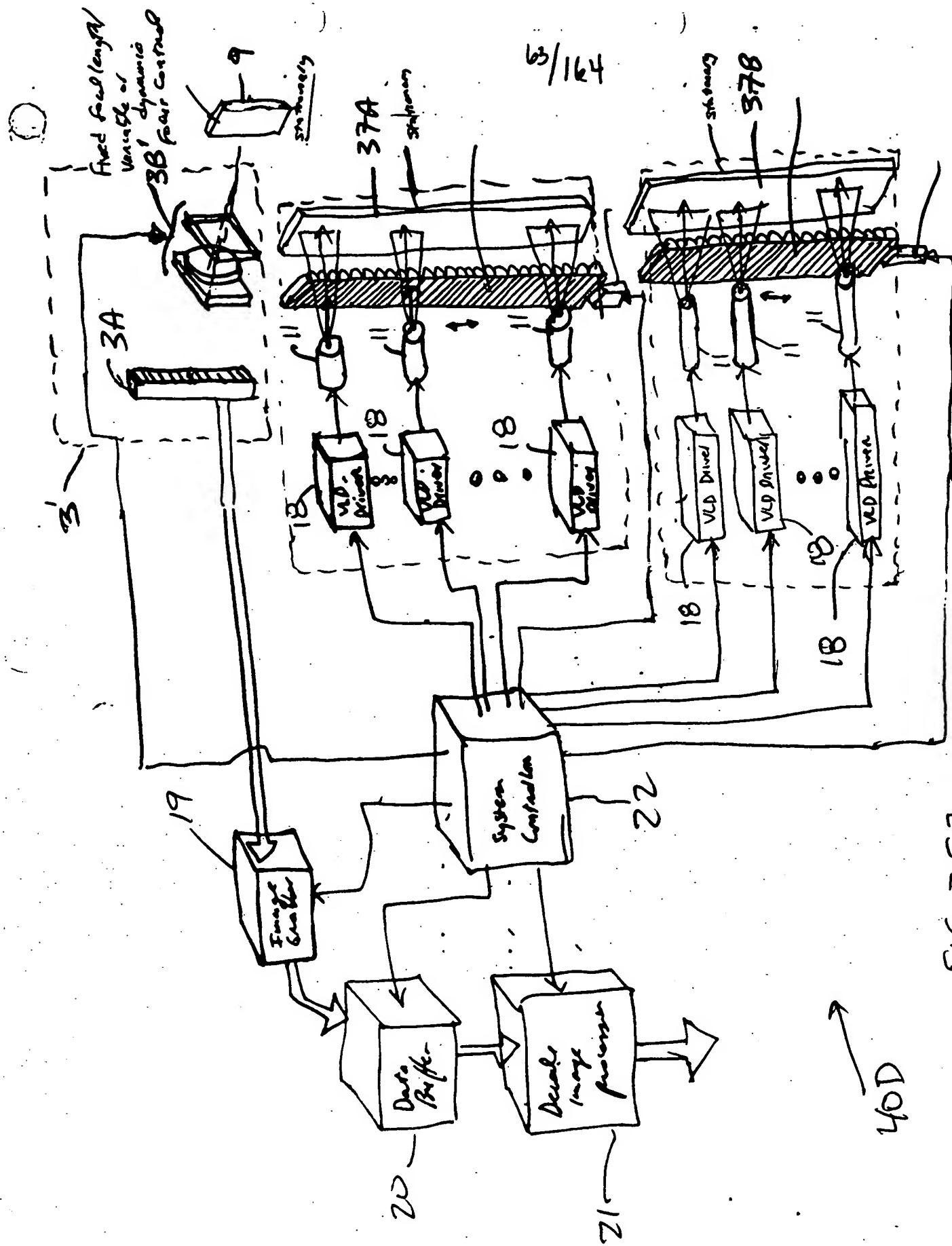


FIG. 2FZ

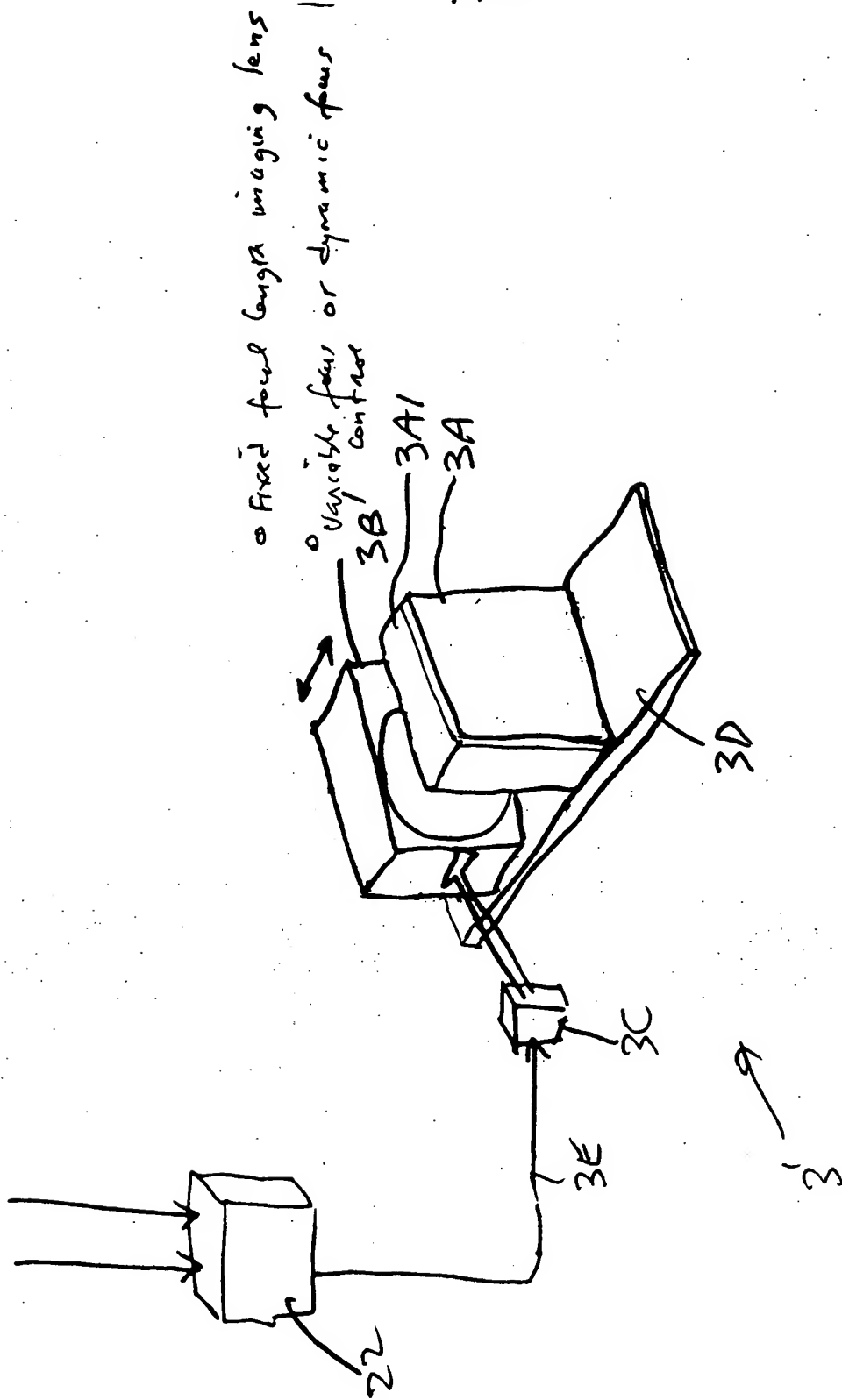


FIG. 2F3

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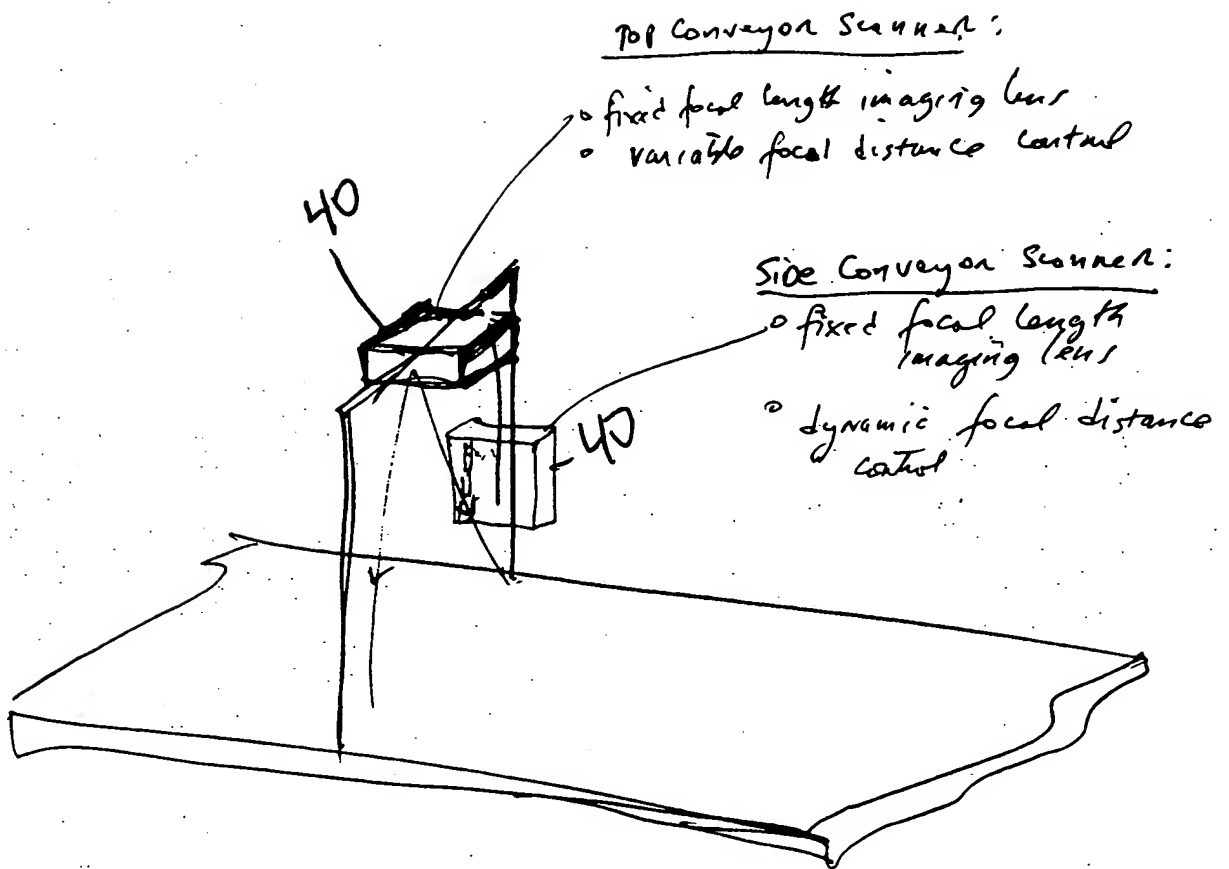


FIG. 2G

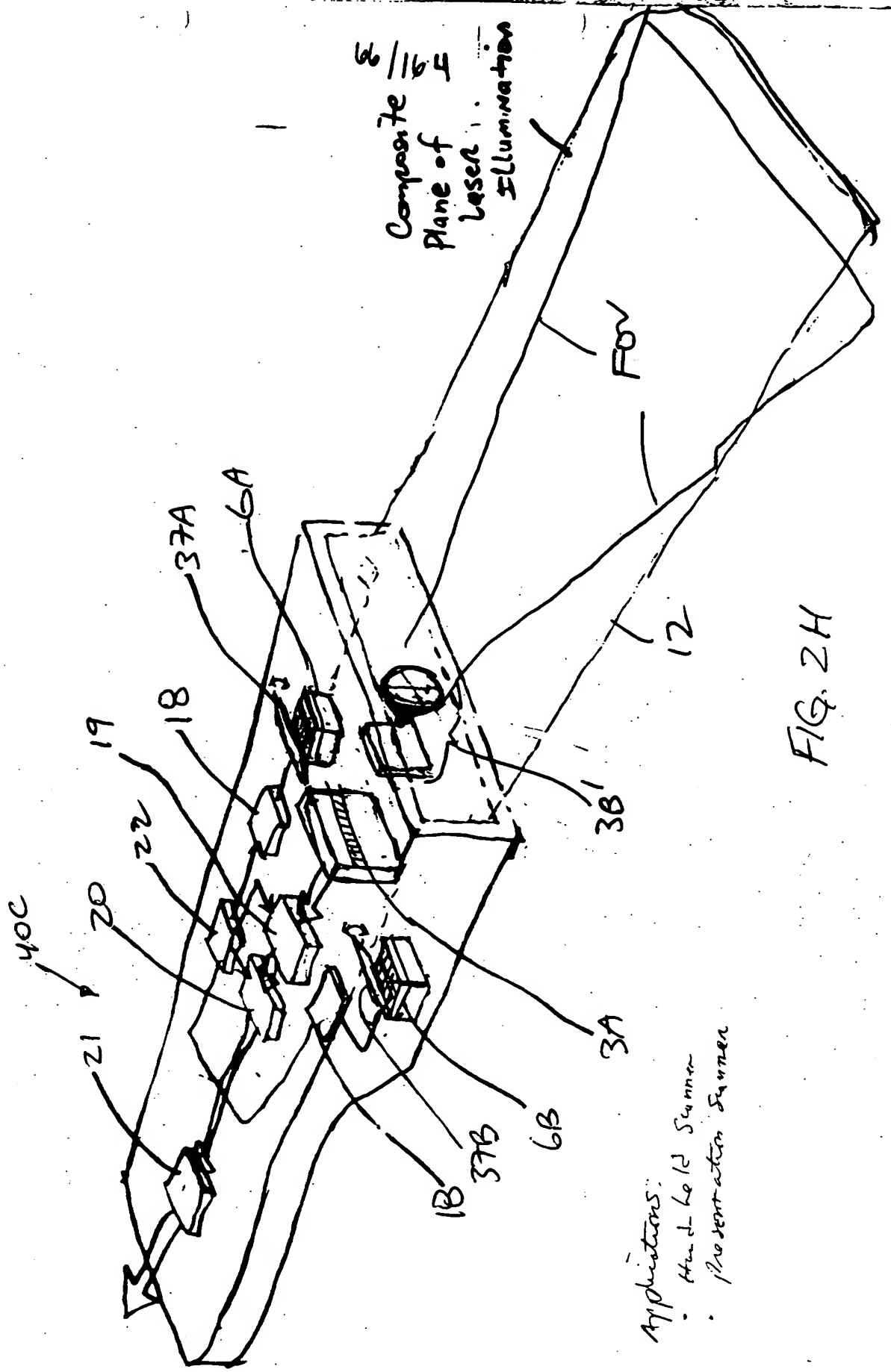


FIG. 2H

Applications:

- Hand Held Scanner
- Presentation Scanner

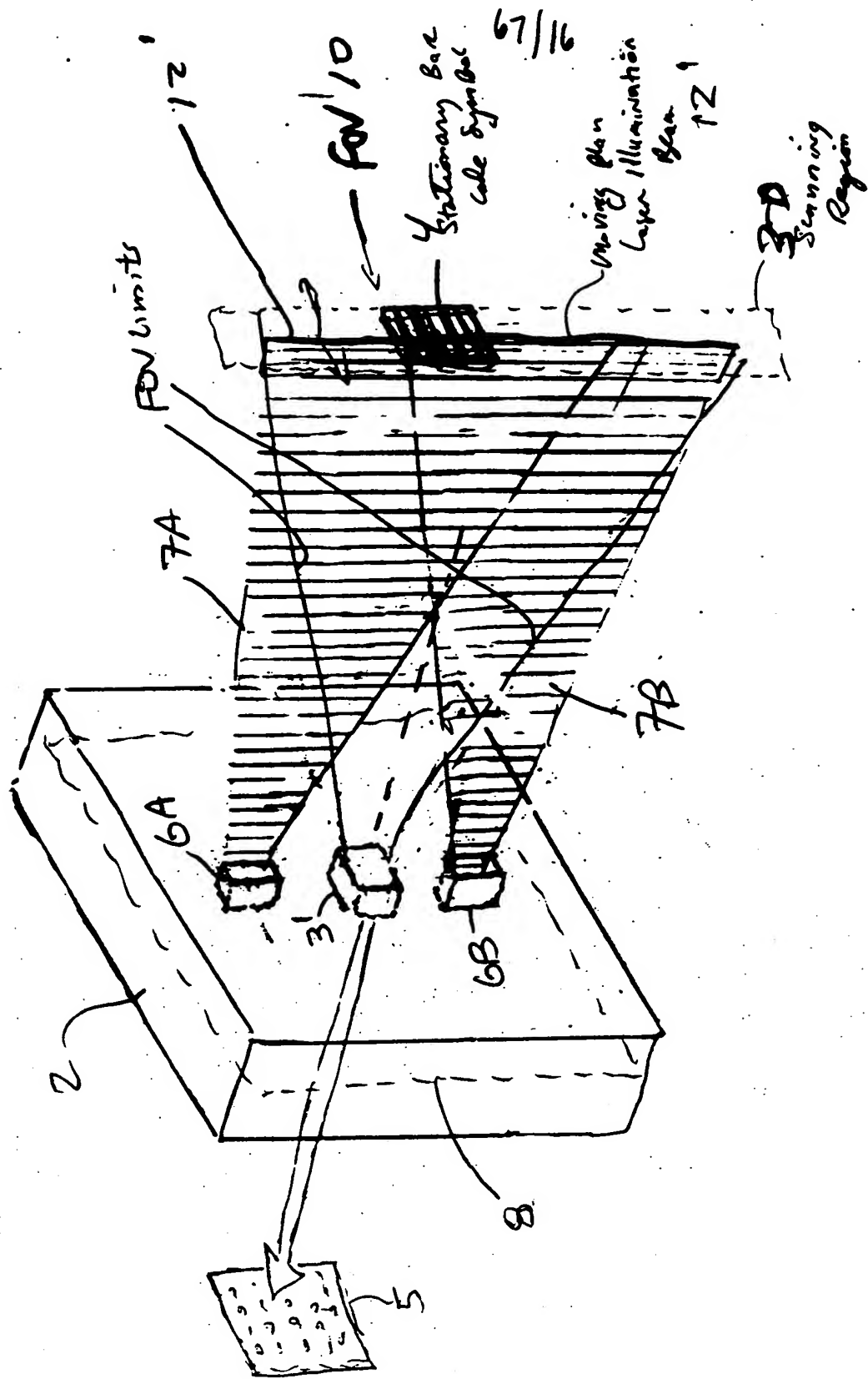
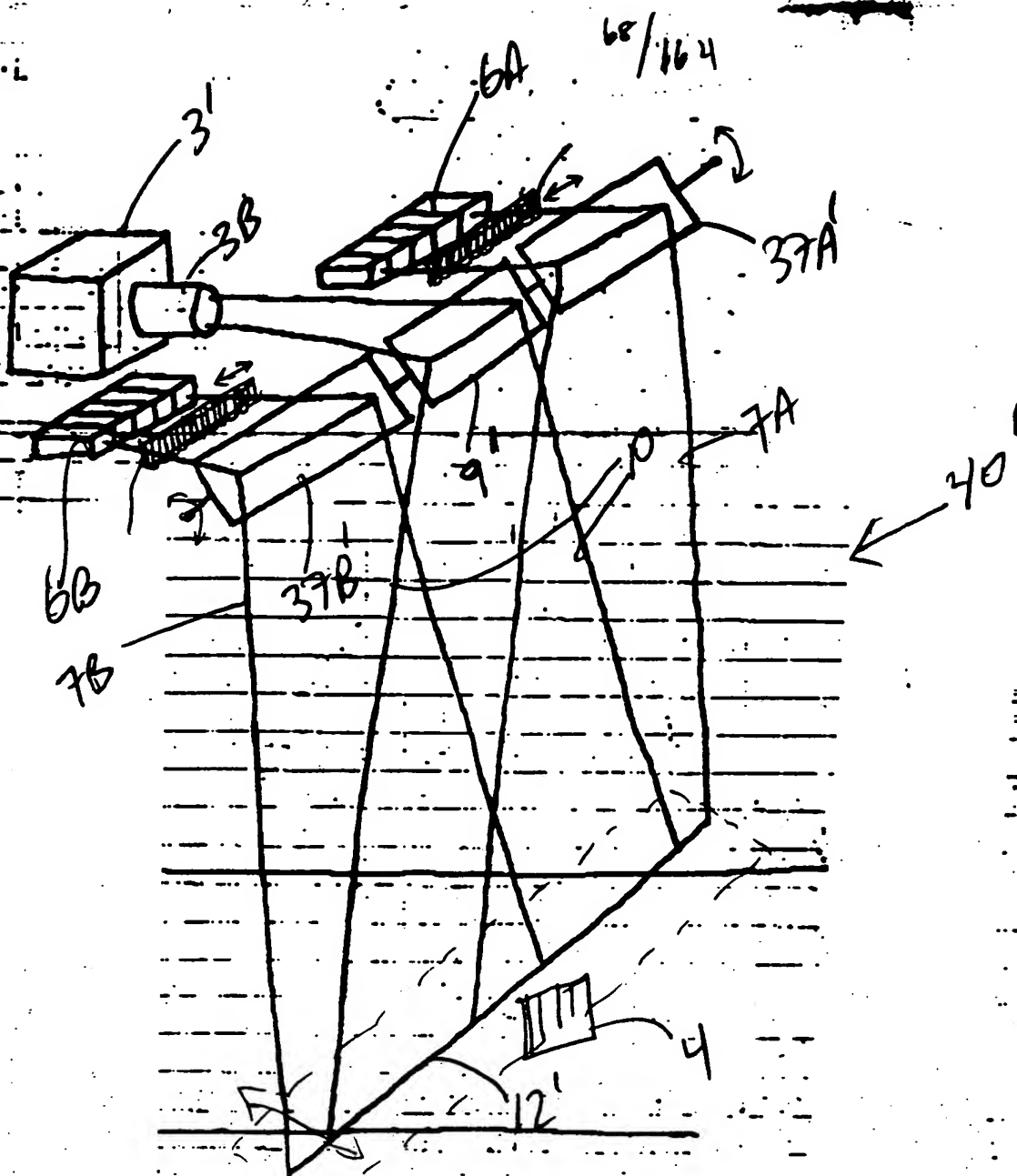


FIG. 2II



3-D  
Scanning  
Region

FIG 2I2

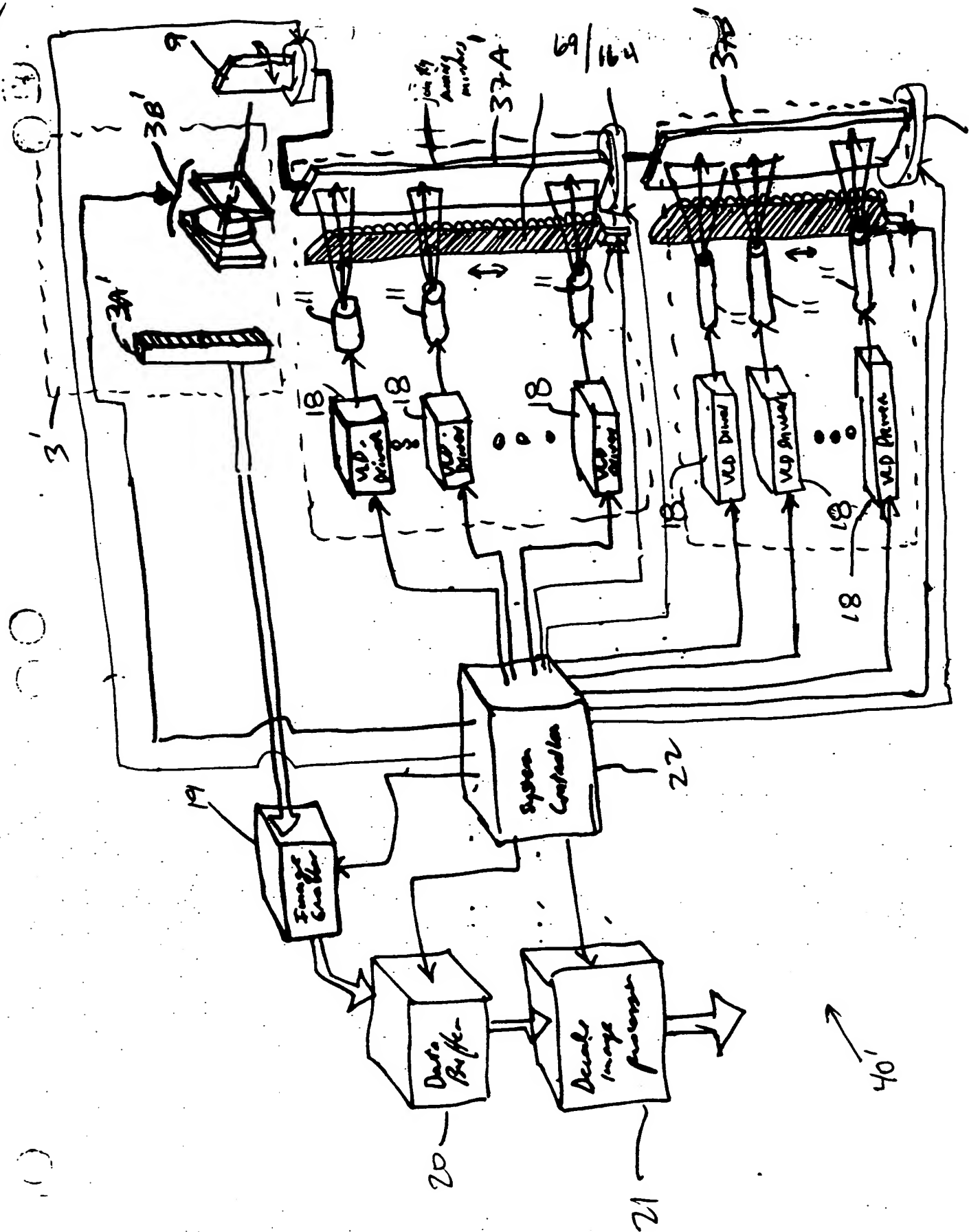


FIG. 2I3

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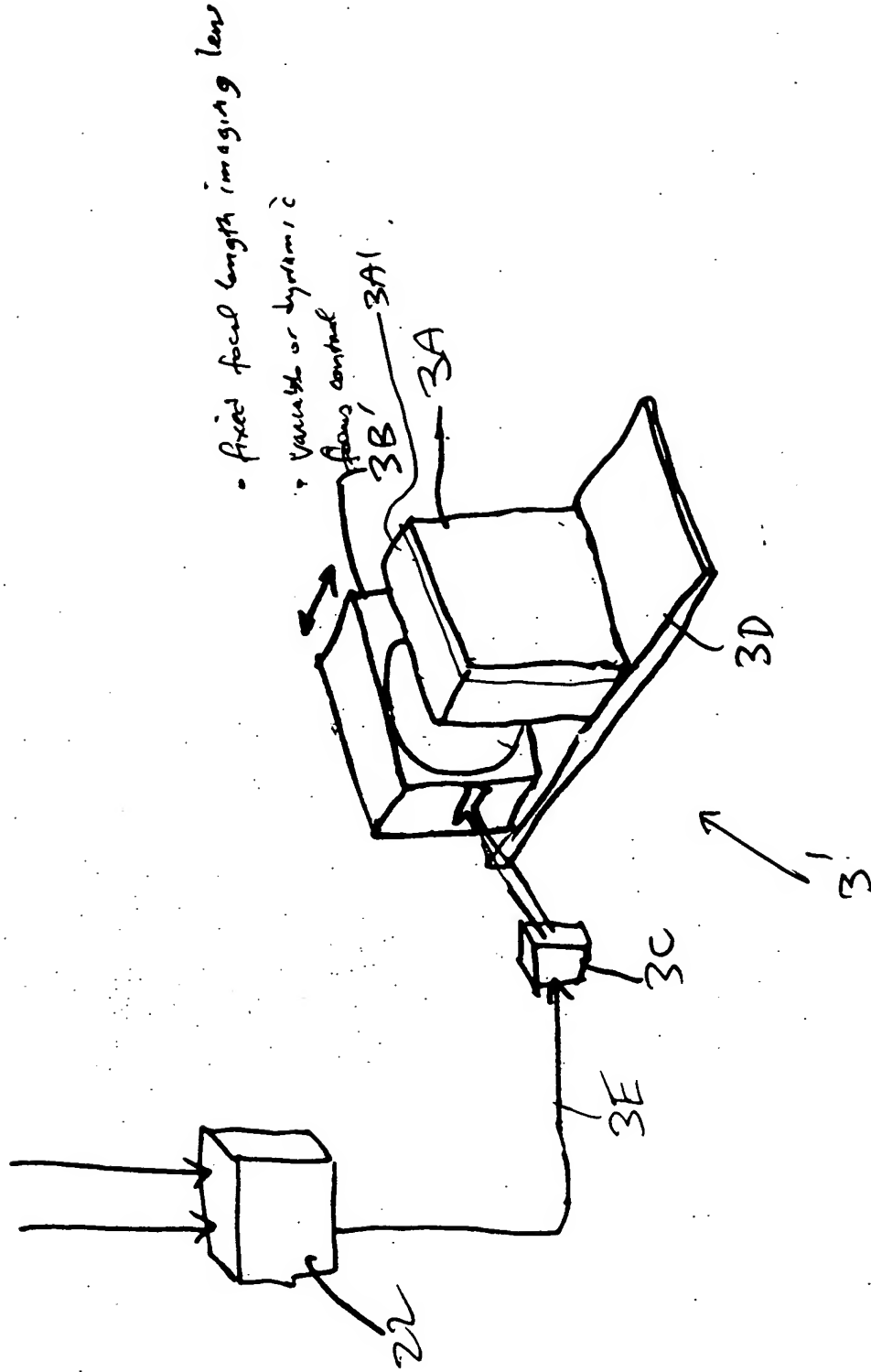


FIG. 2I4

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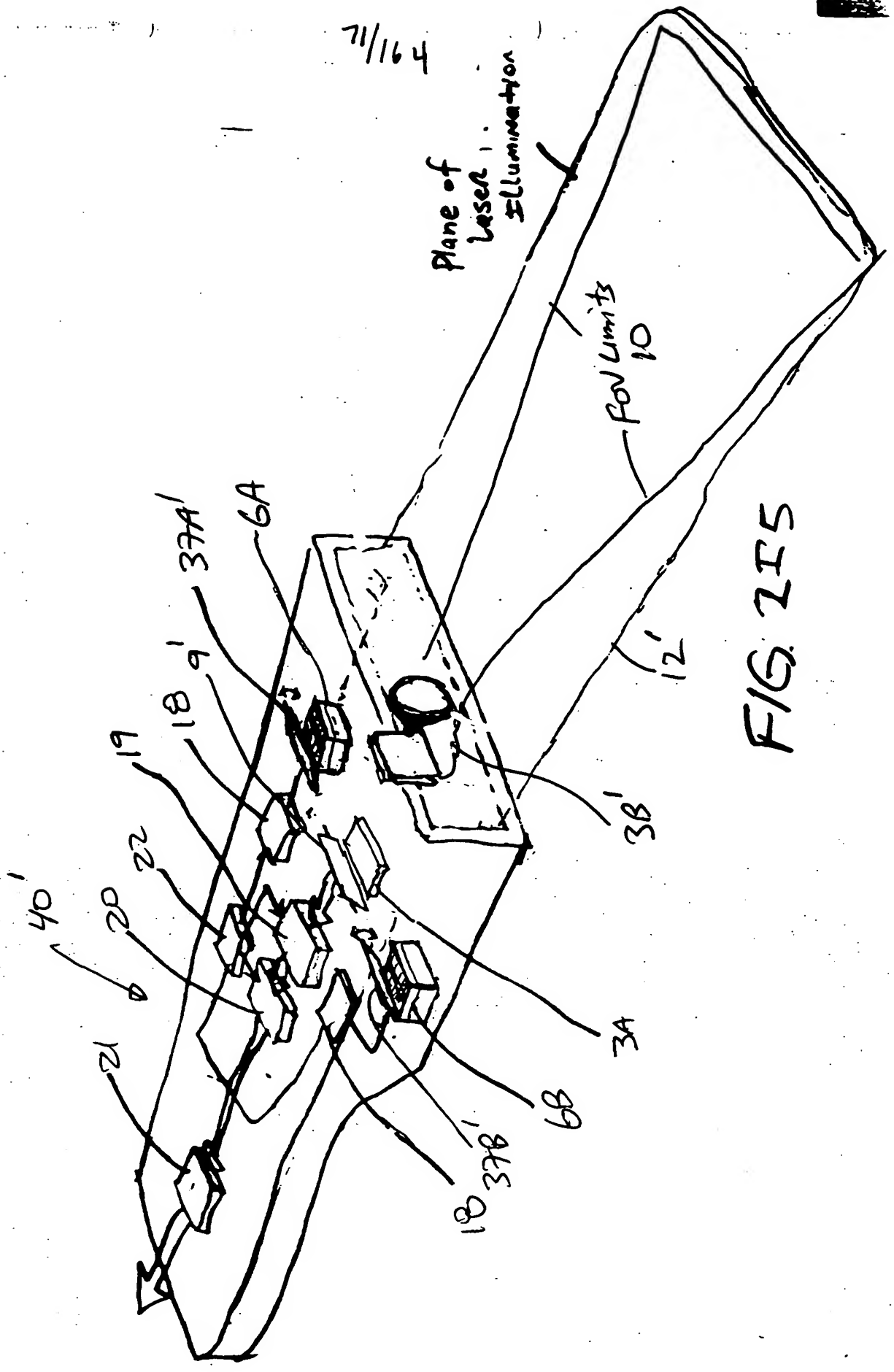


FIG. 215

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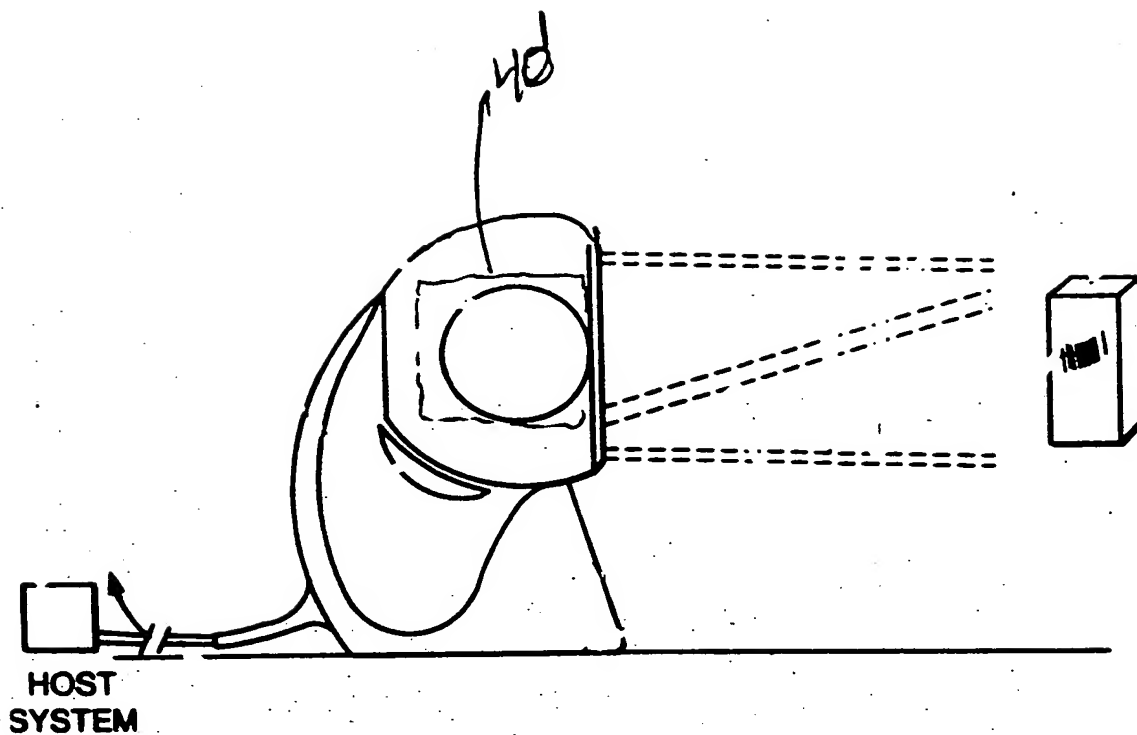


FIG. 2I6

○



FIG. 3A

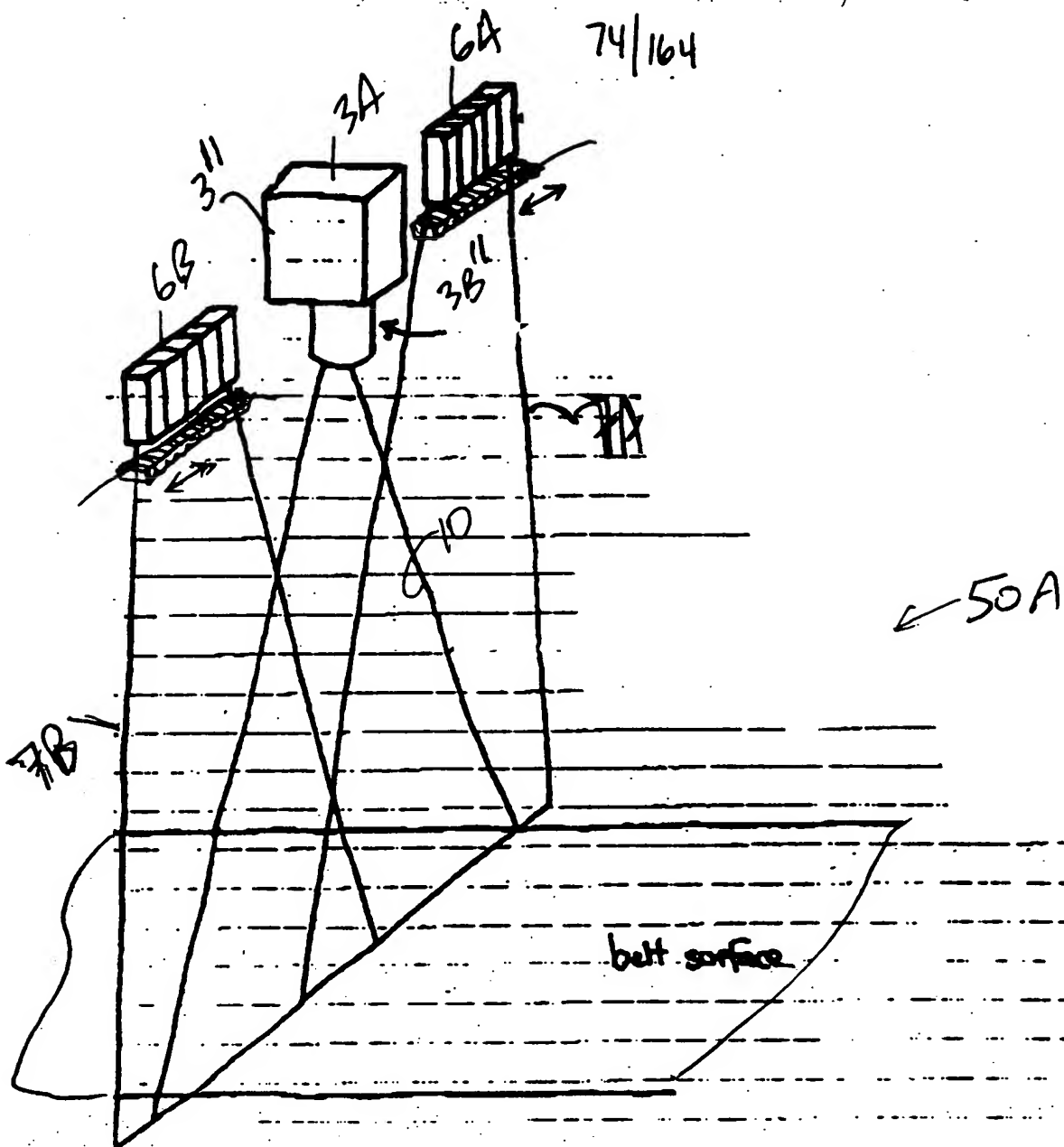
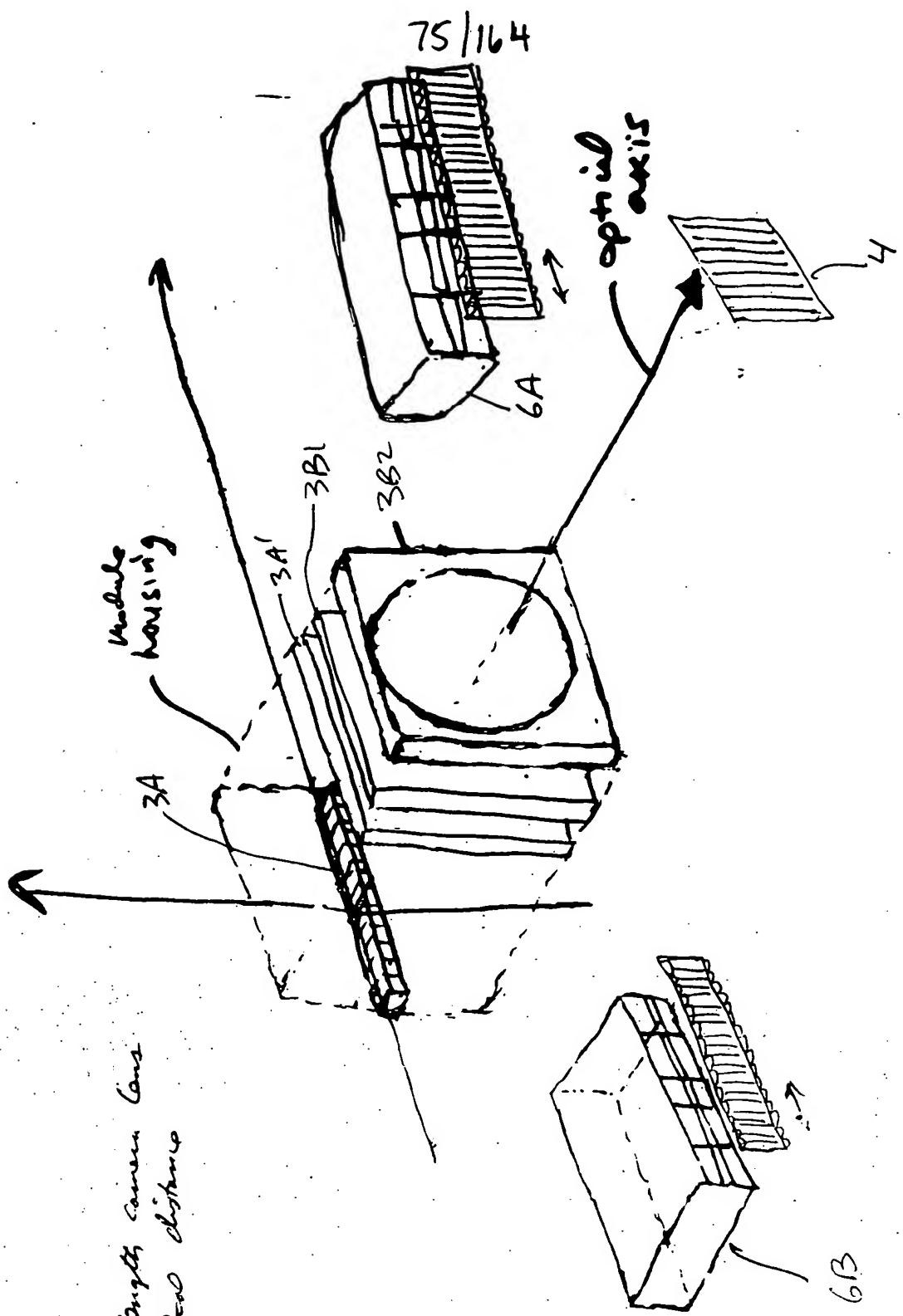


FIG. 3B1



- (1) Variable focal length camera lens
- (2) Variable focus distance

FIG 3B2

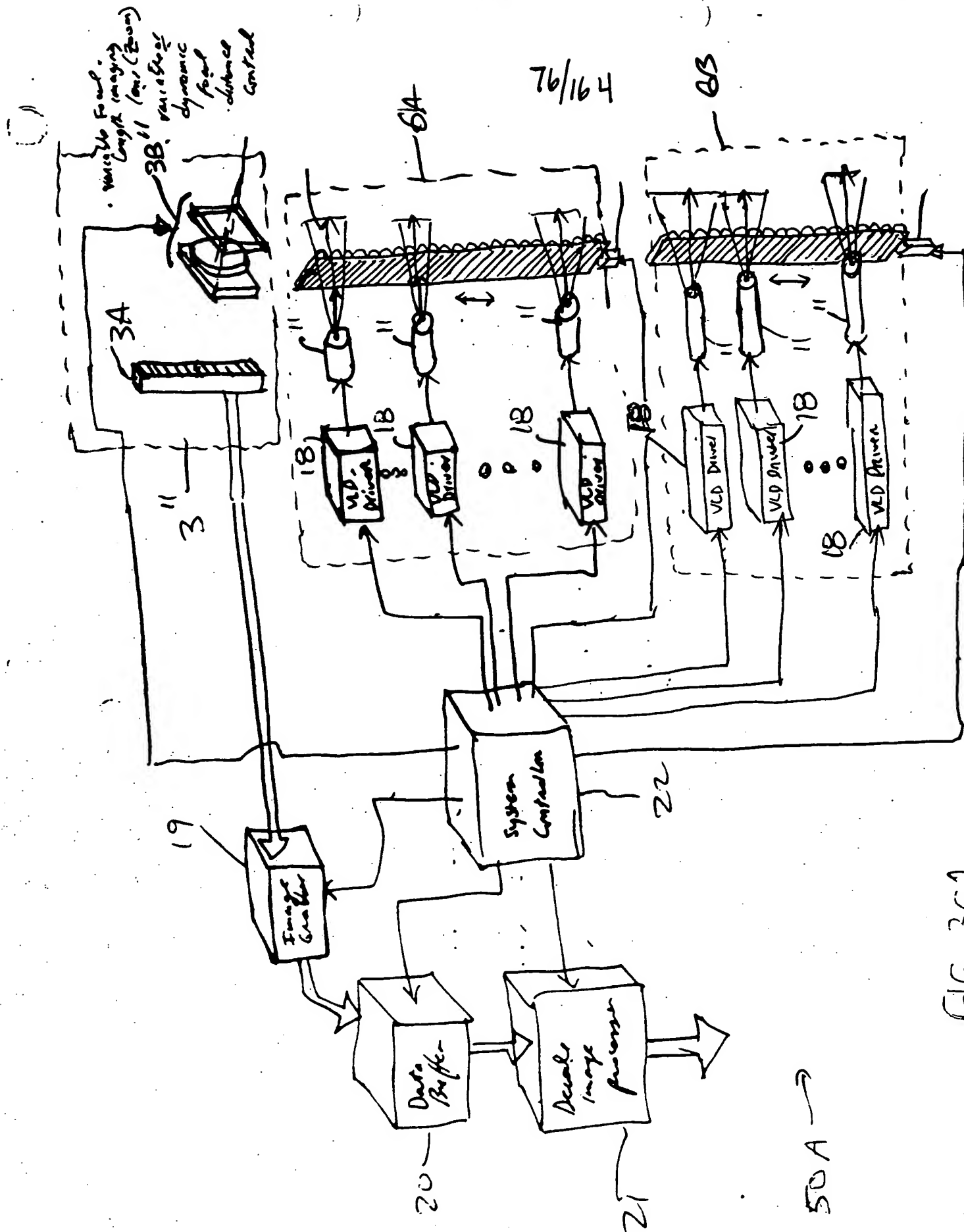
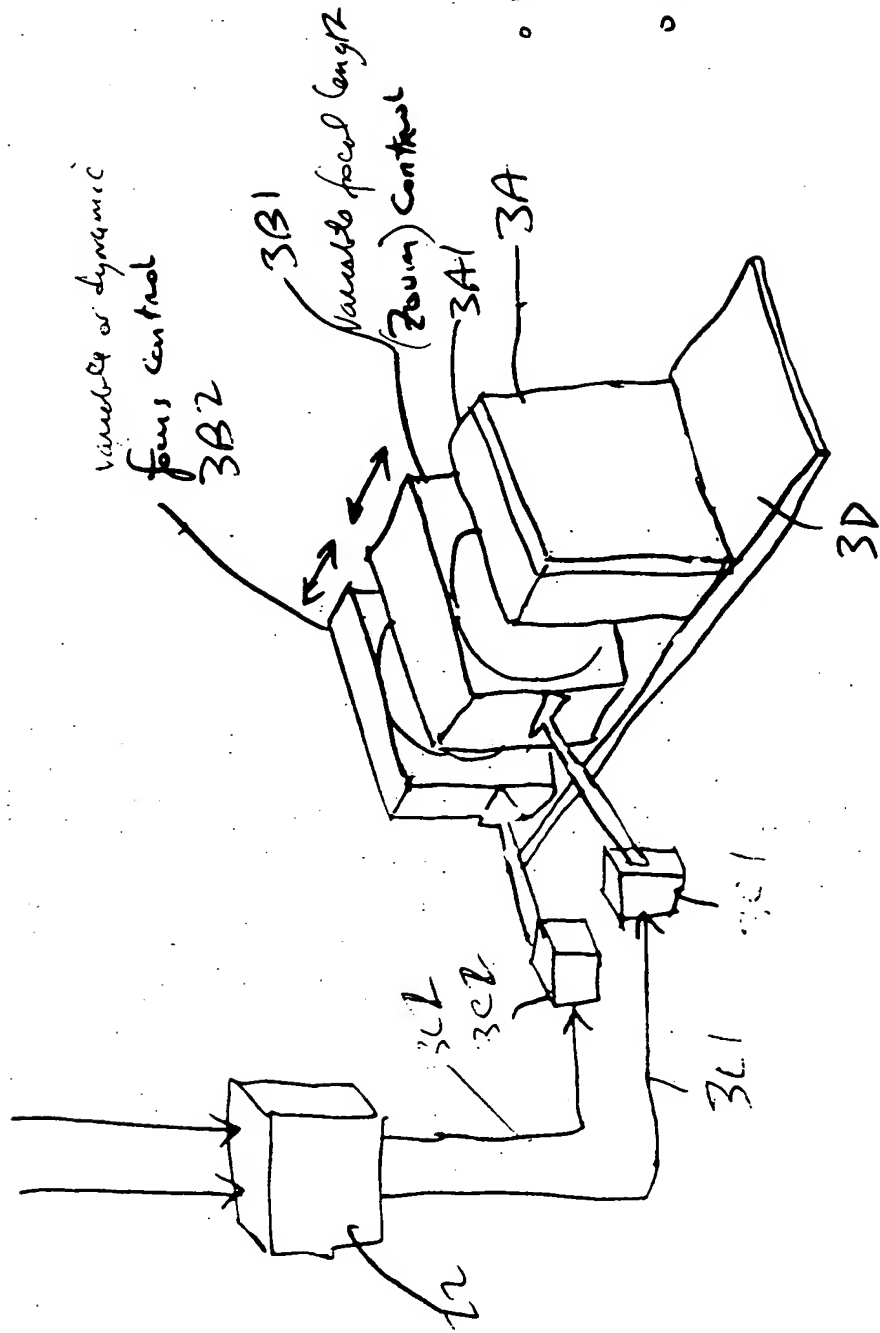


FIG 3C1



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◦ Variable focal length camera lens

◦ Variable focus distance

FIG. 3C2

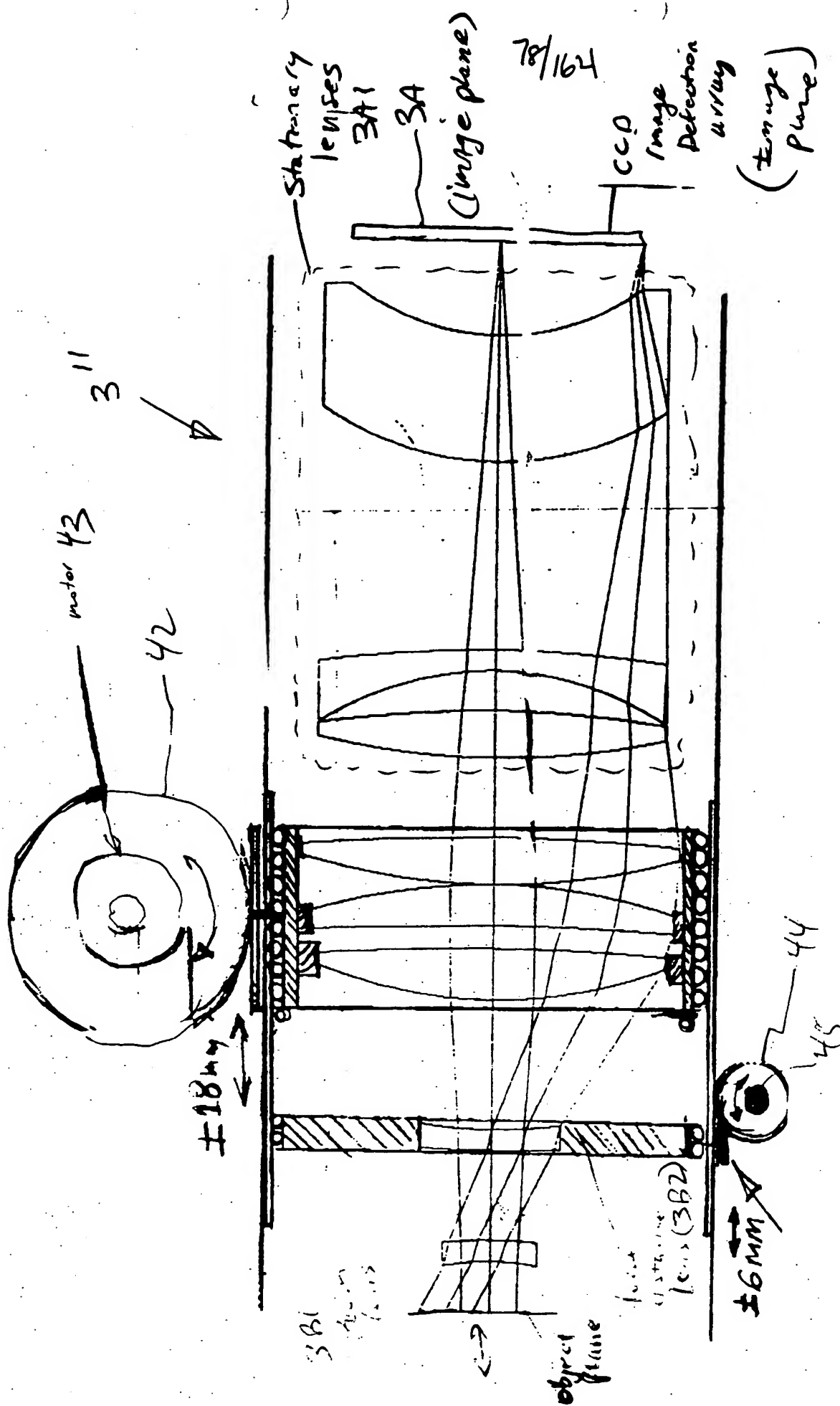


FIG. 3D

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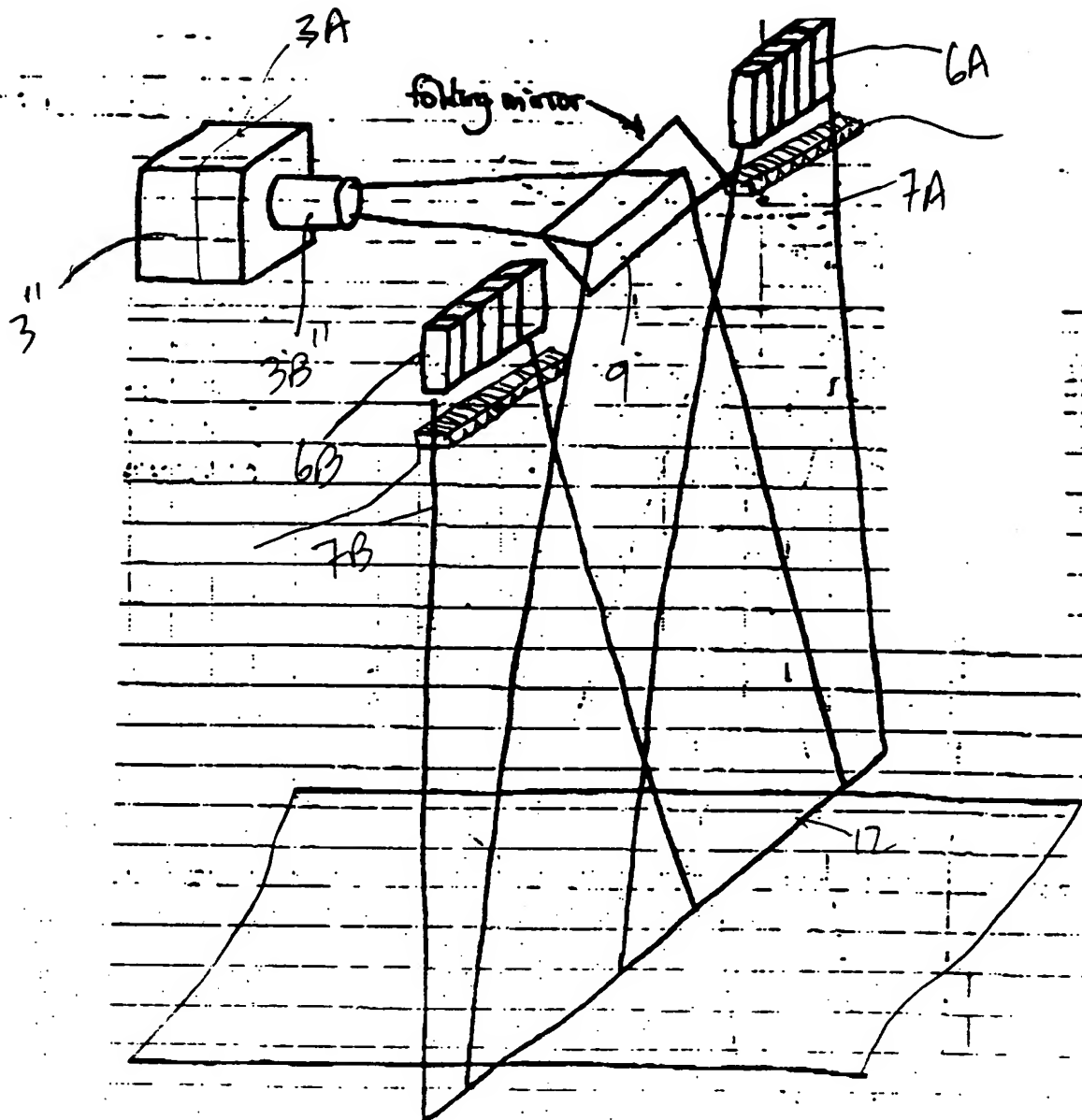


FIG 3E1

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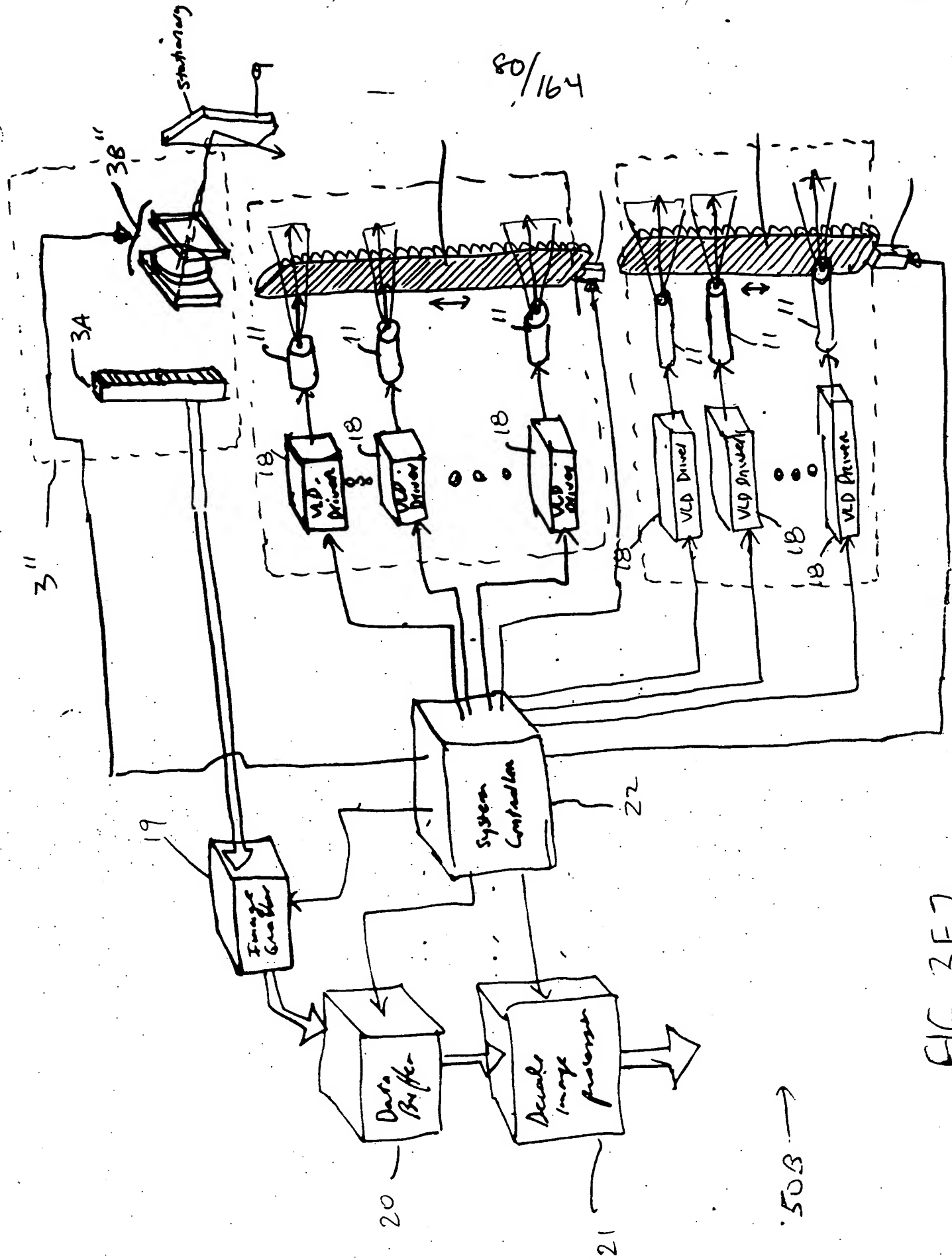


FIG. 3E2

503 →

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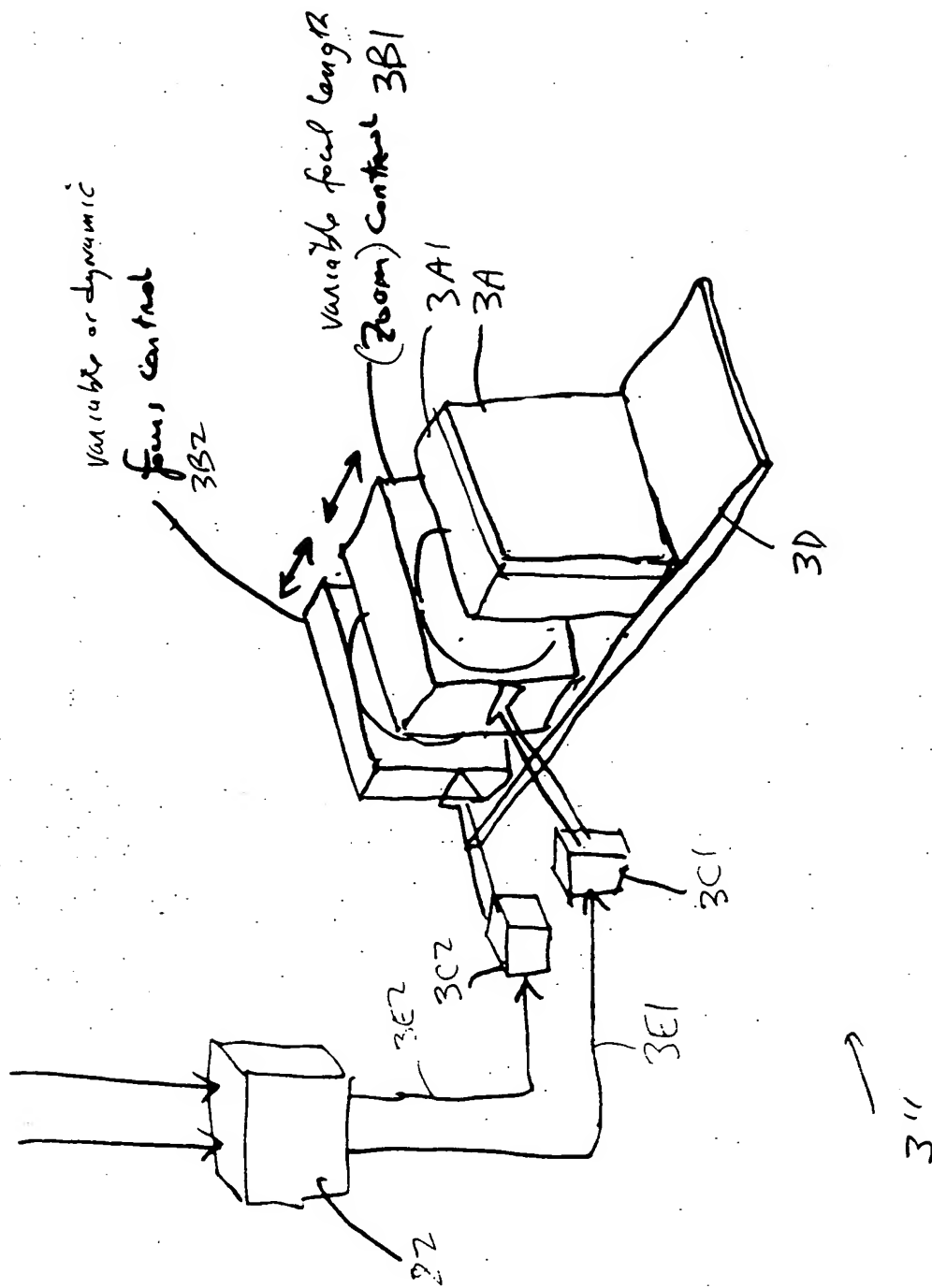
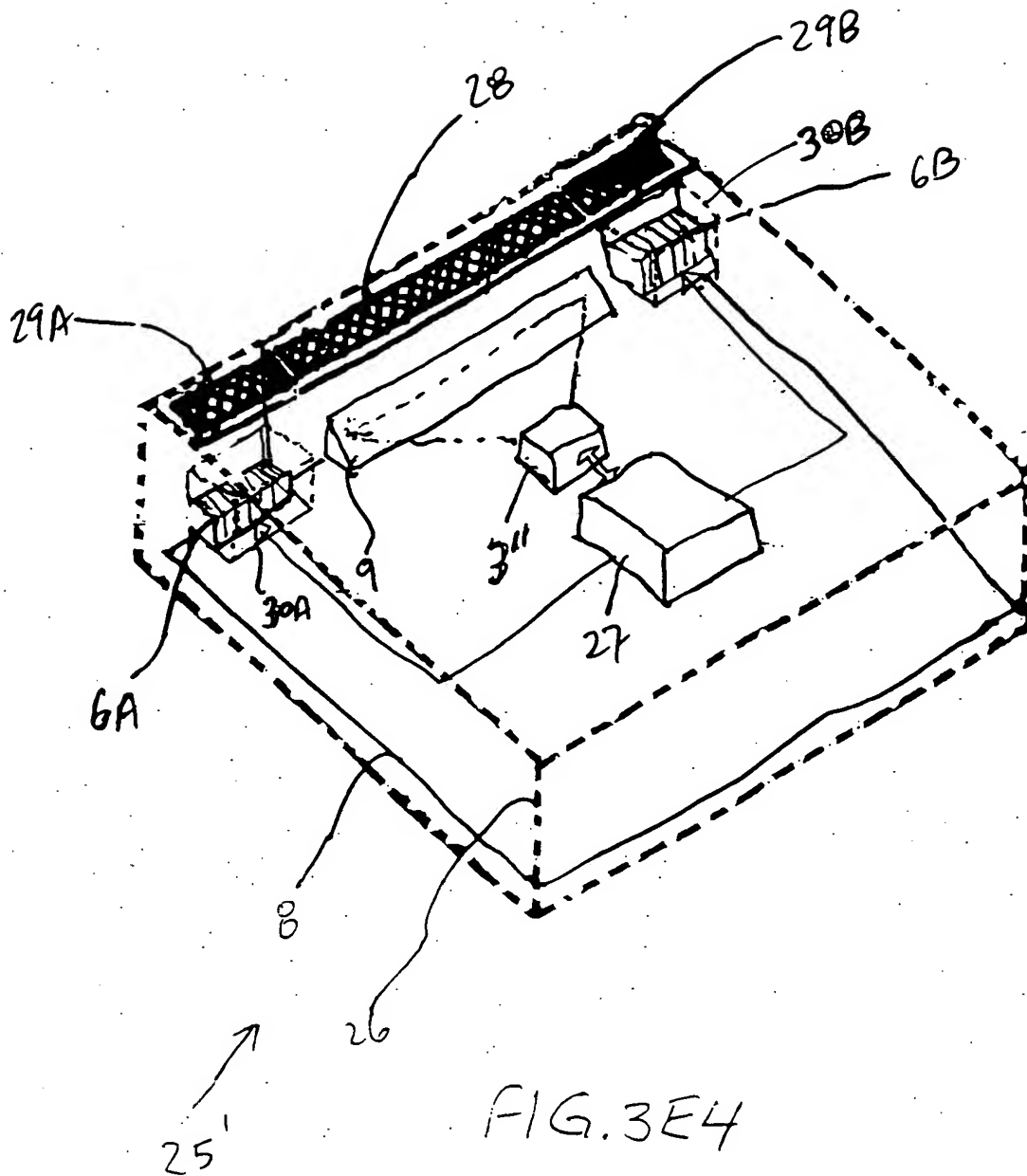


FIG. 3E3

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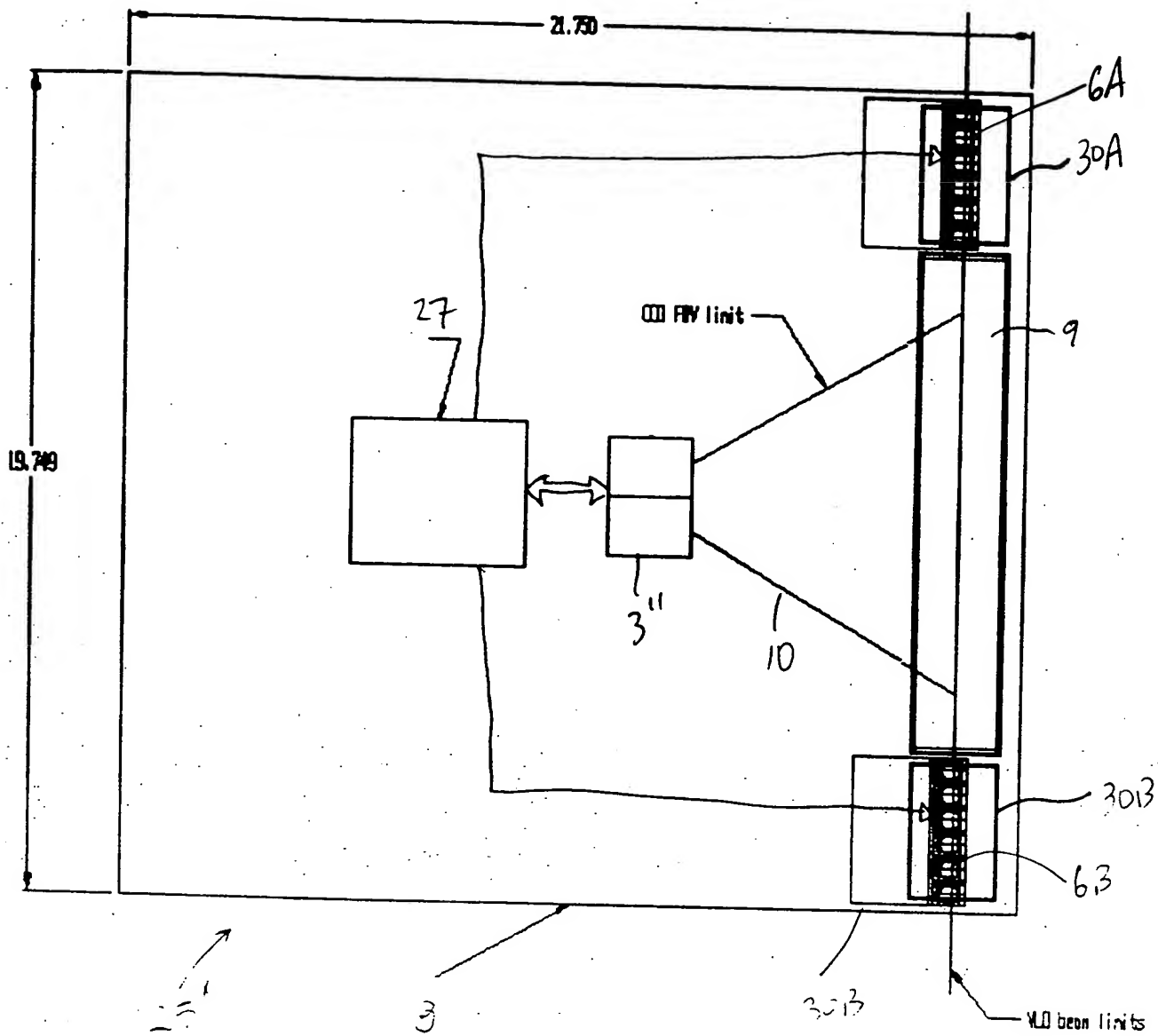


FIG. 3E5

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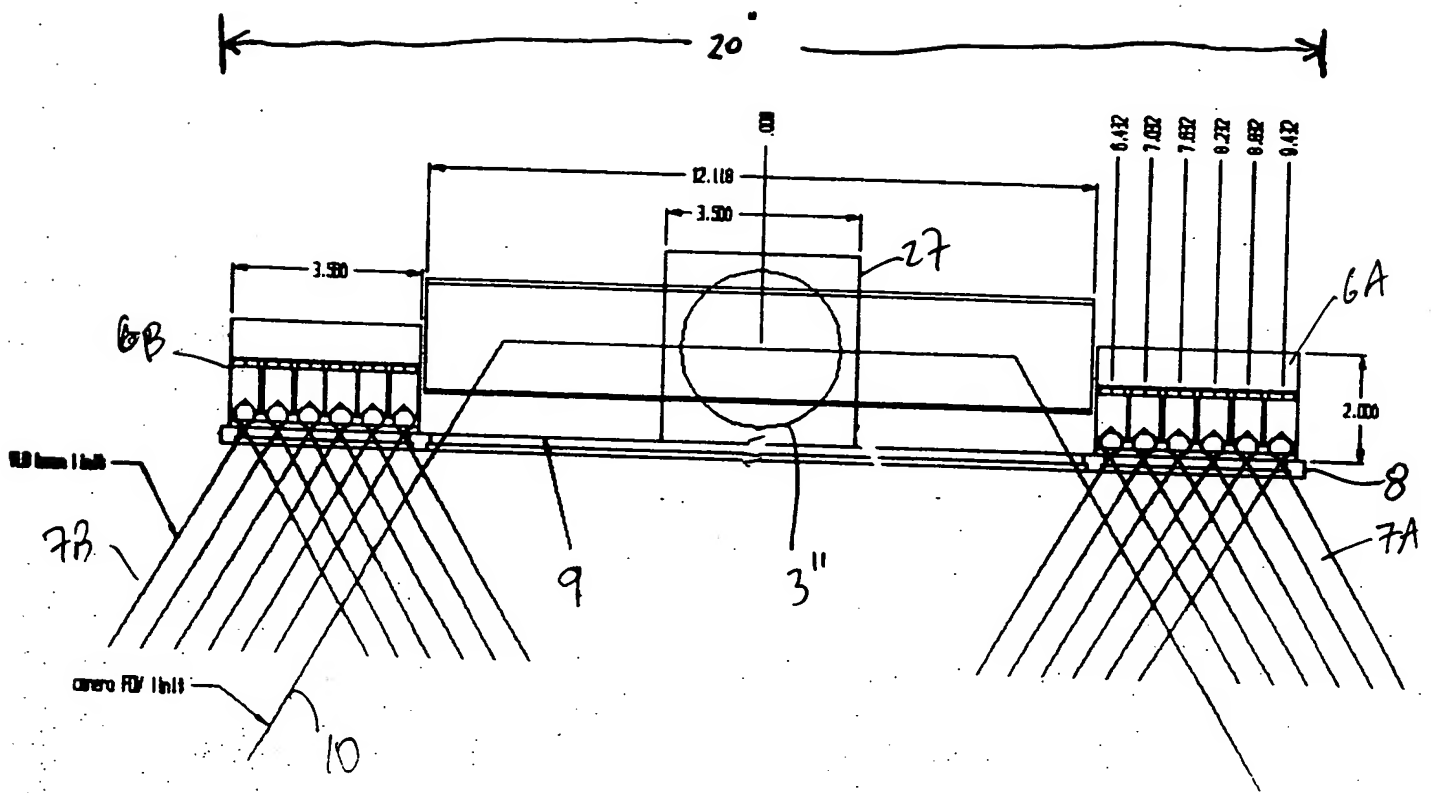


FIG. 3E6

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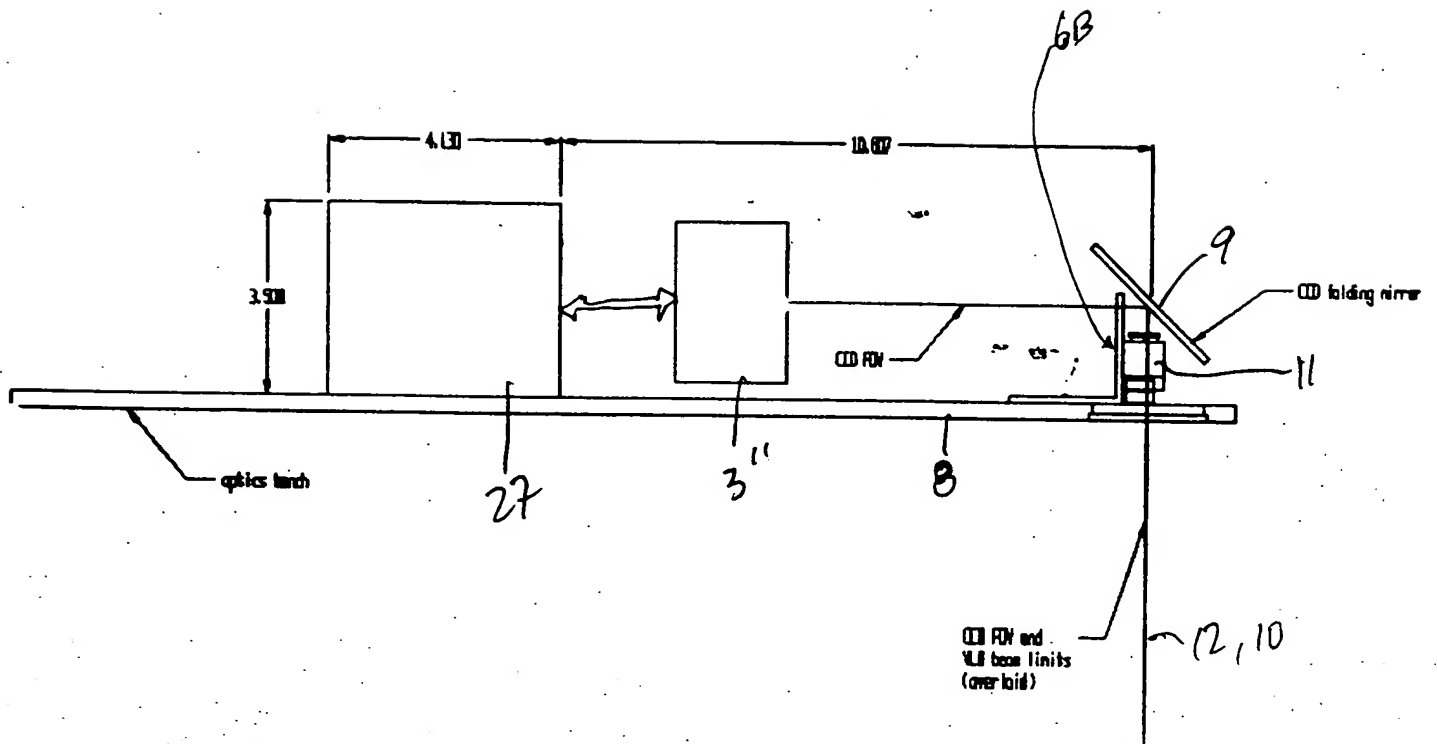


FIG 3E7

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\*Variable FOV

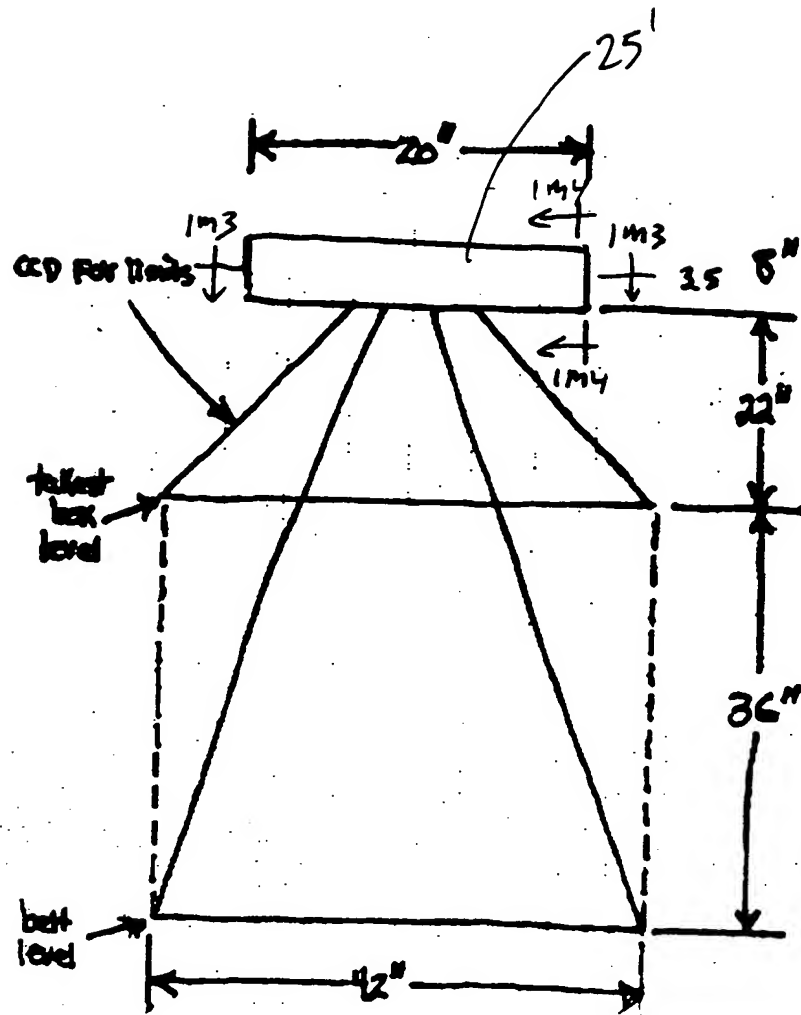


FIG. 3E8

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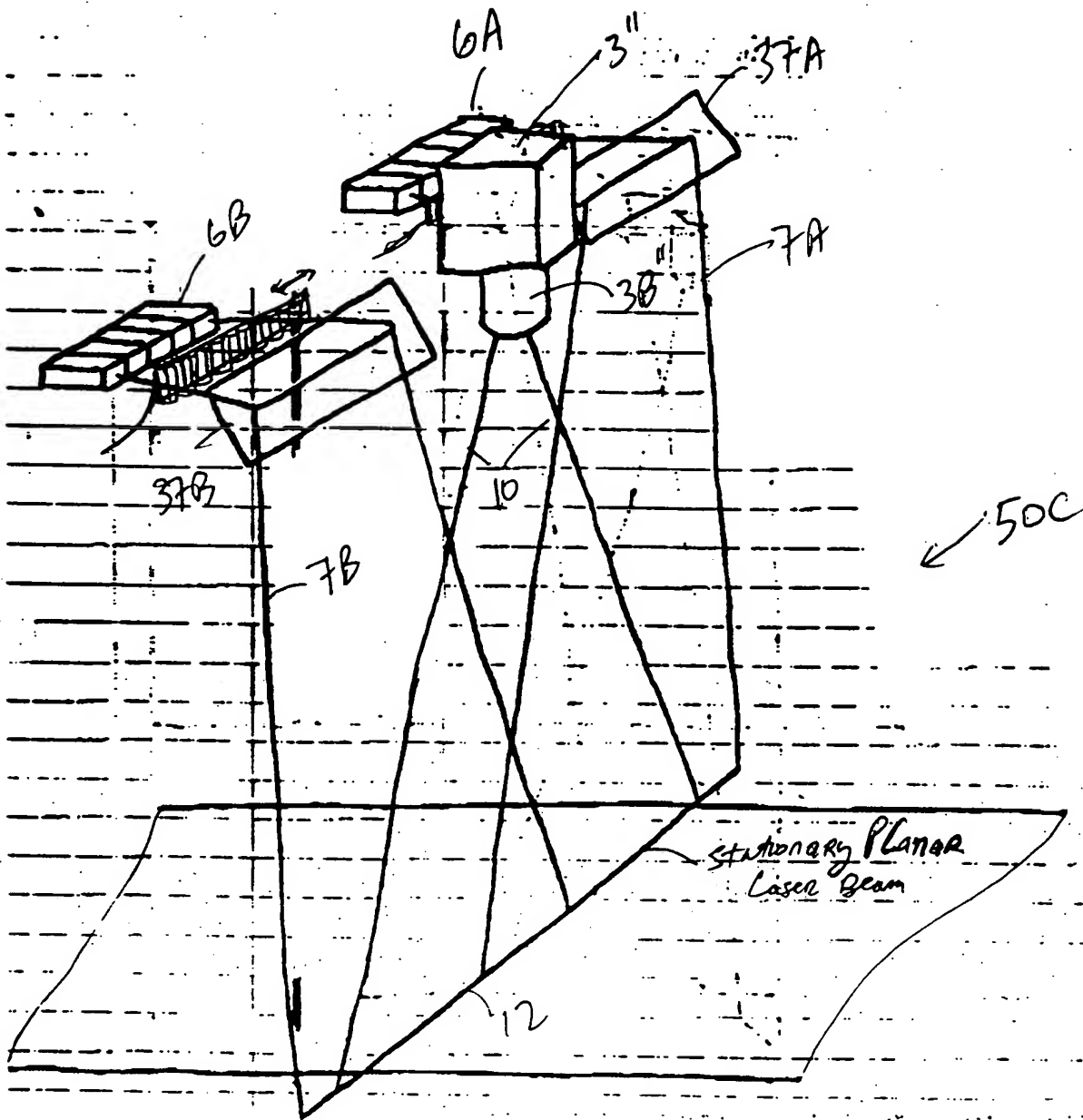
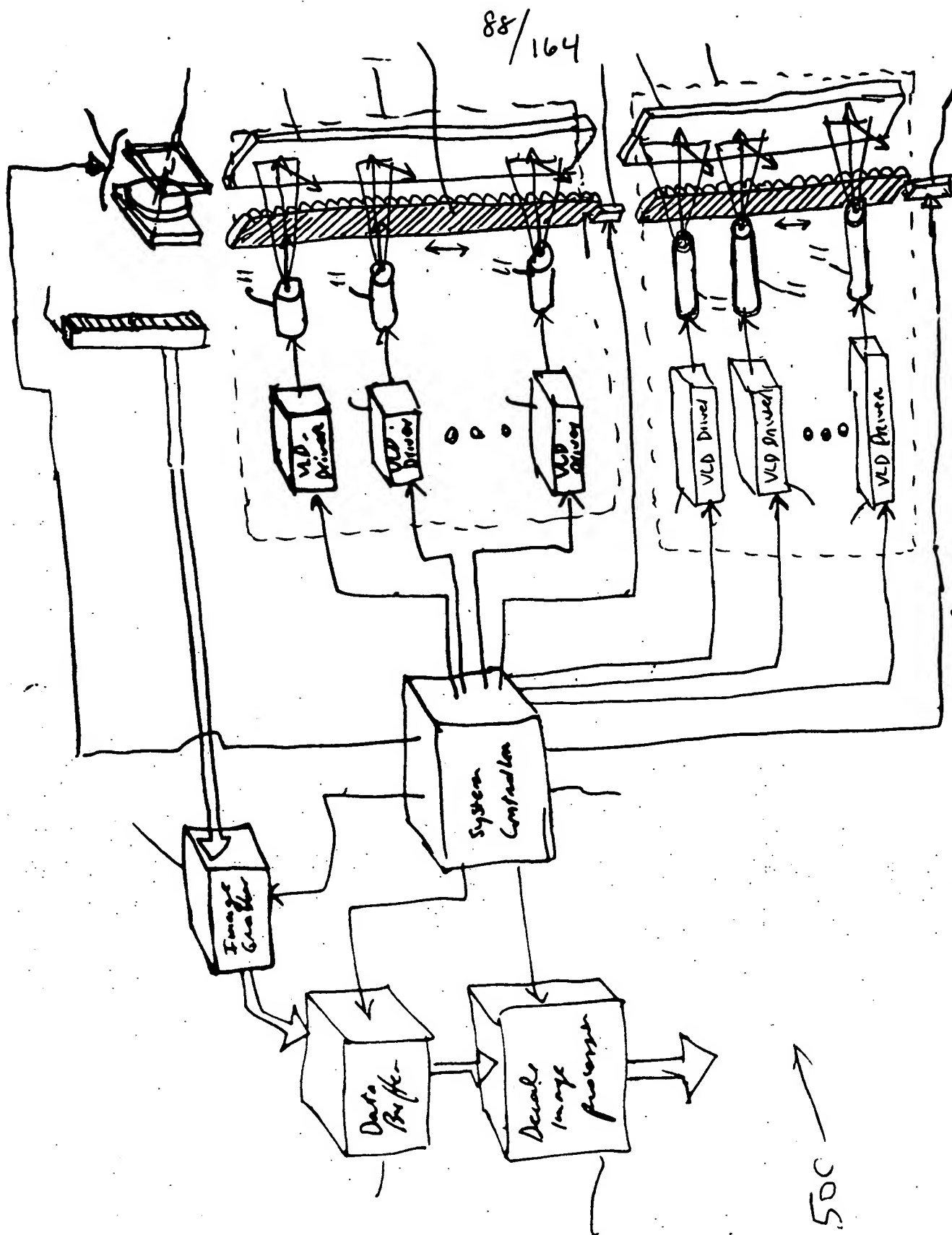


FIG. 3F1



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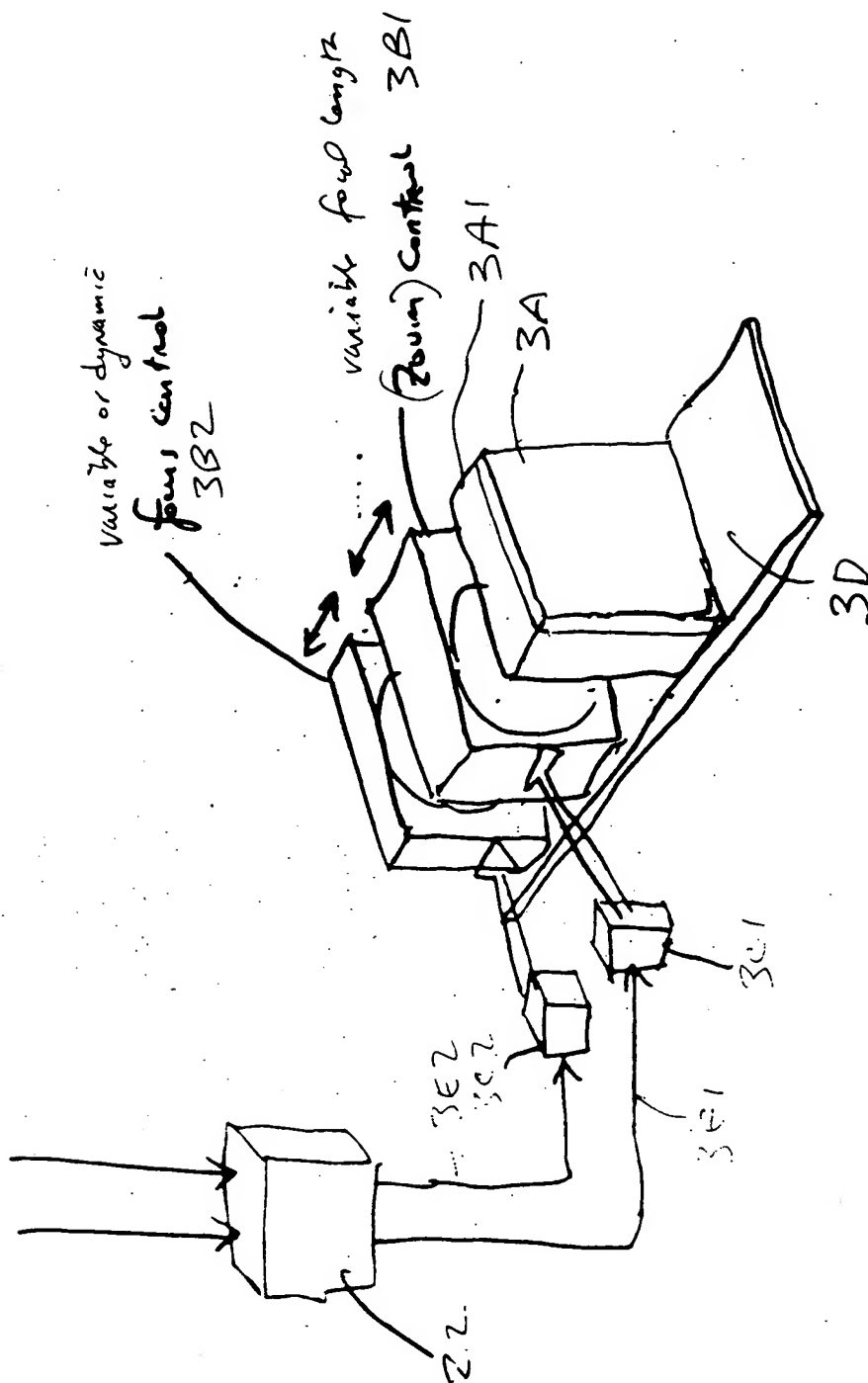


FIG. 3F3

3"

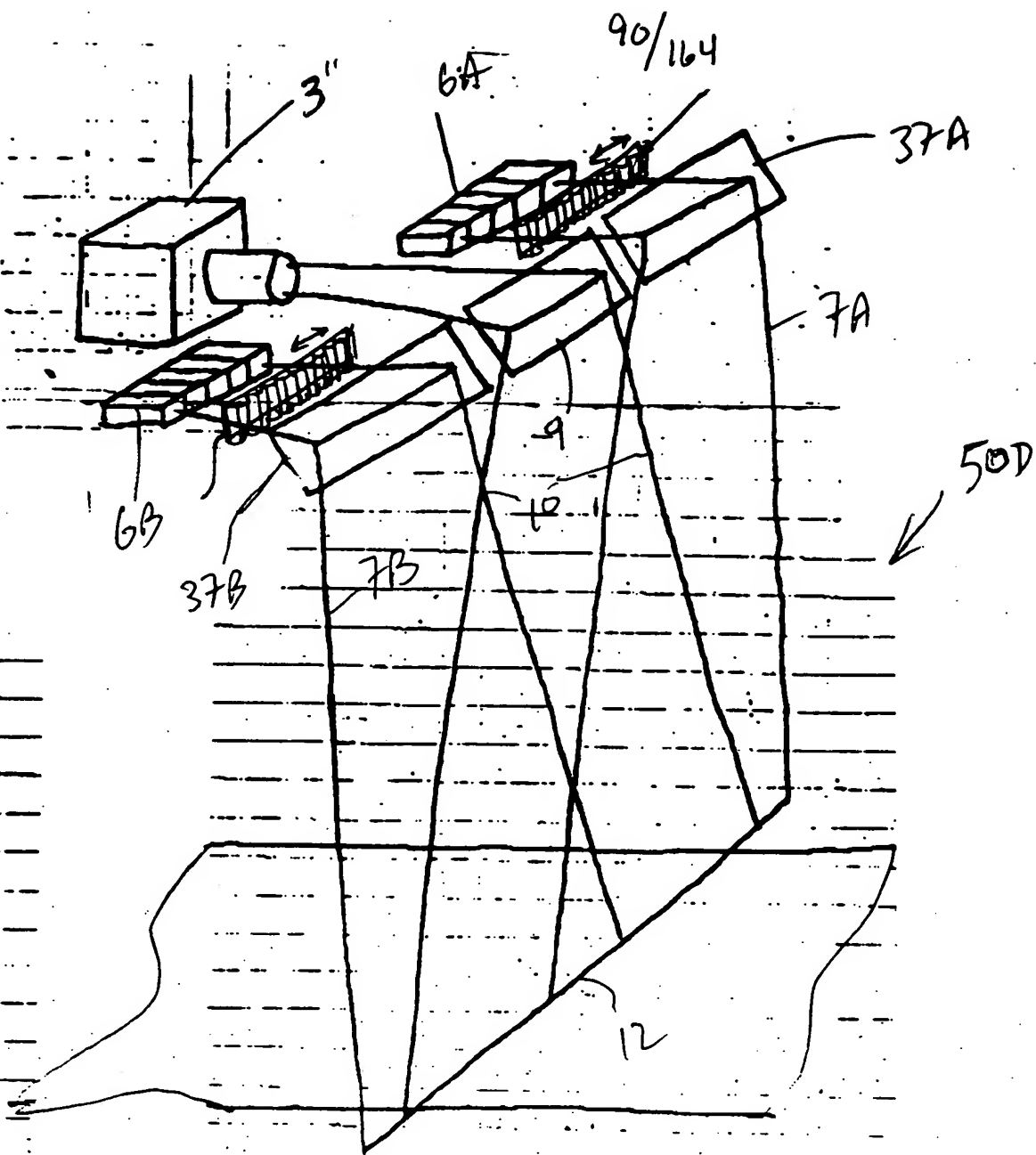


FIG. 3G1

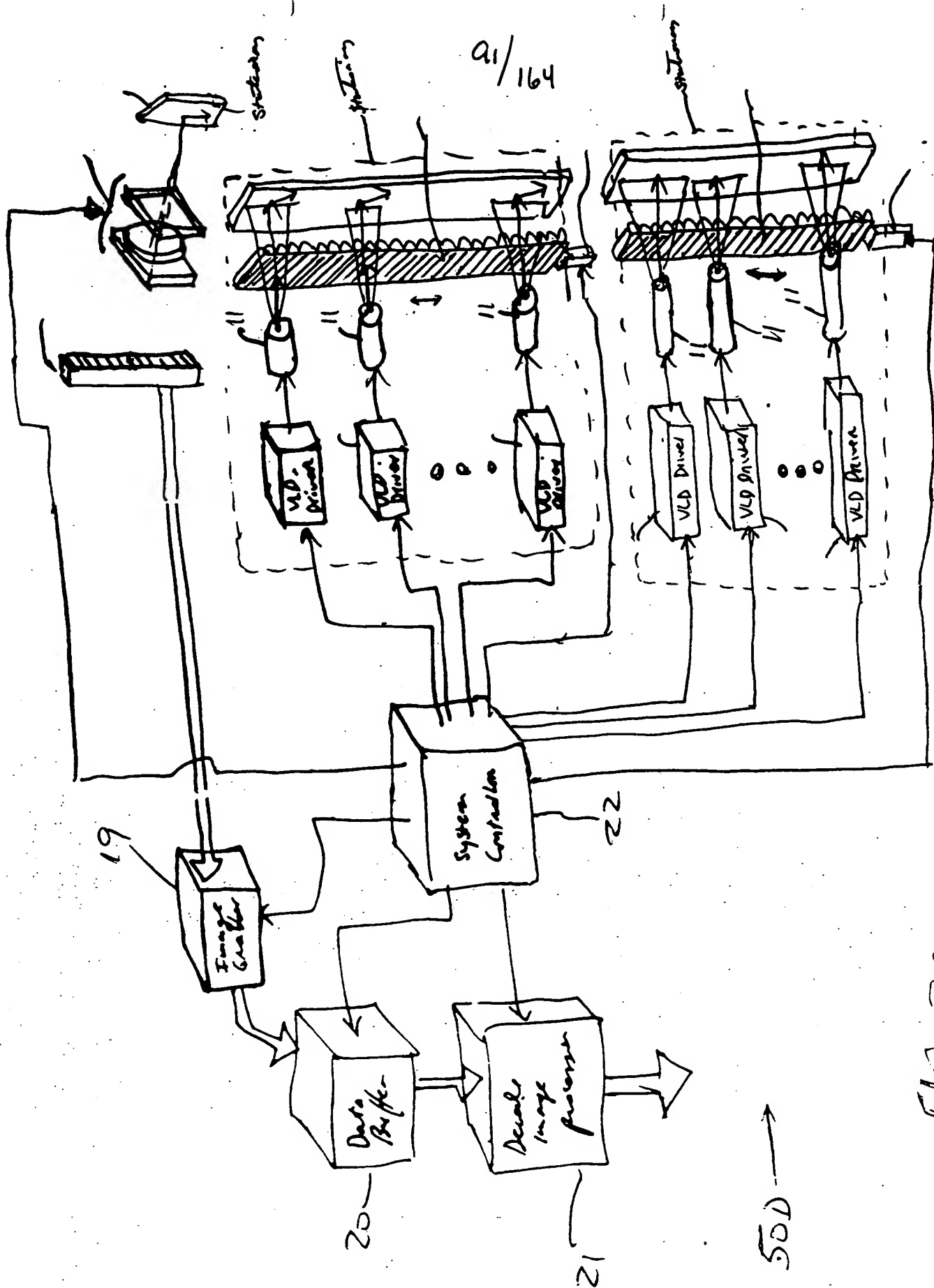


FIG 392

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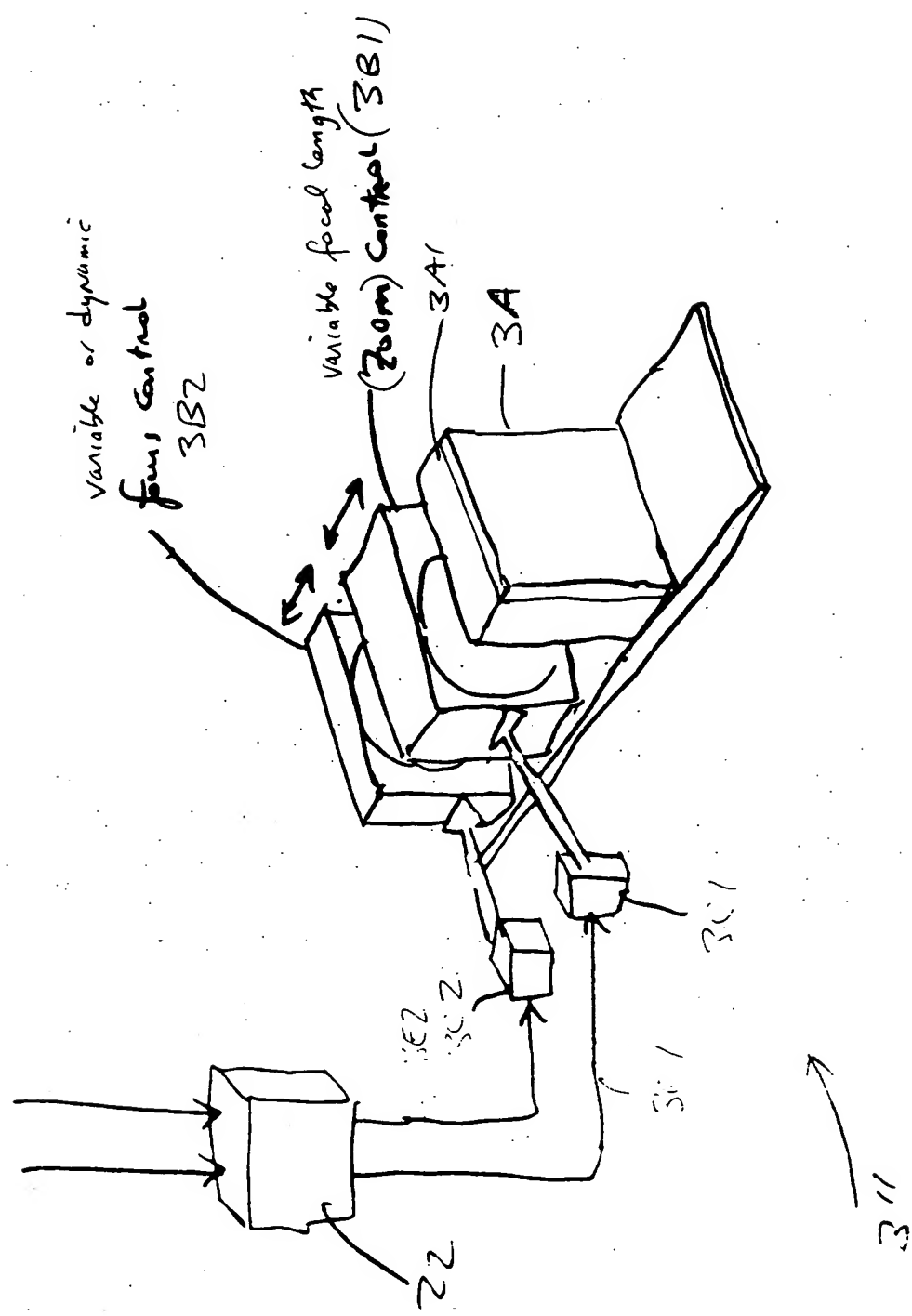


FIG. 3Q3

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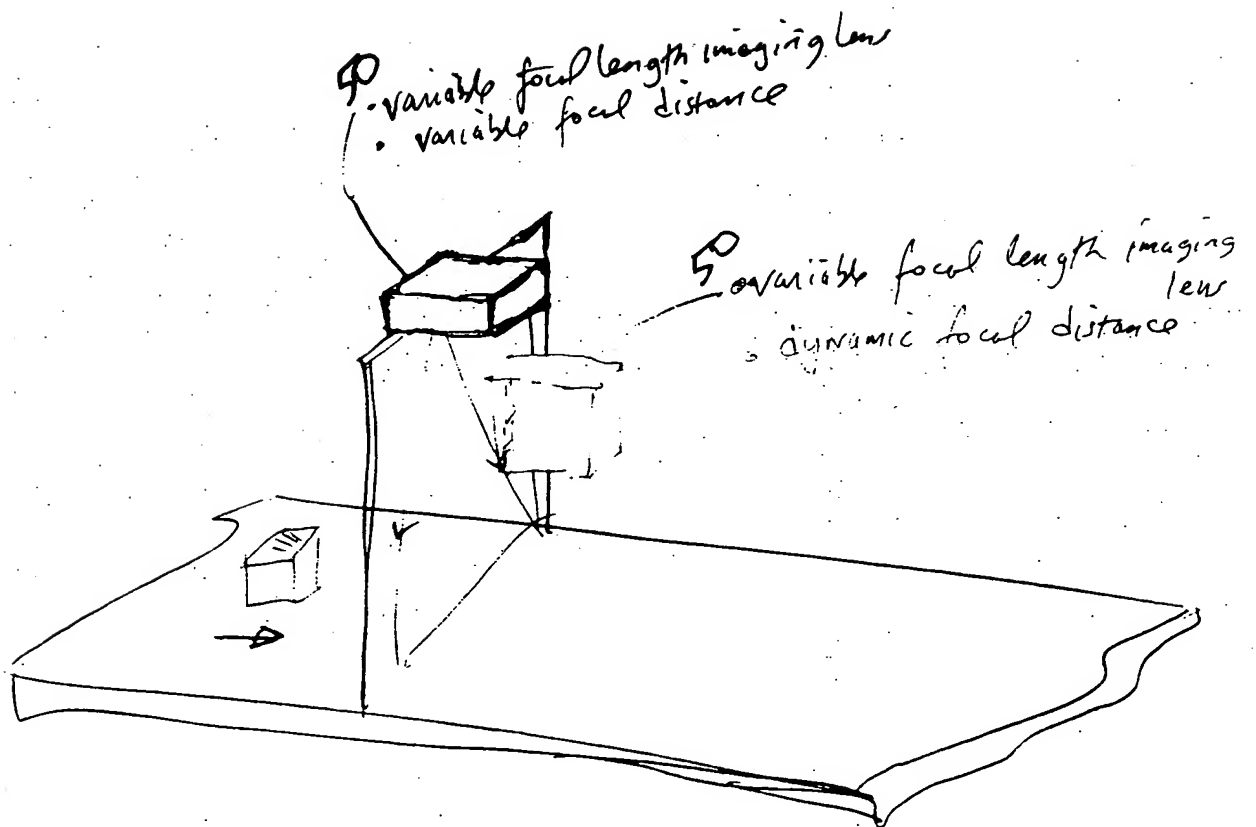
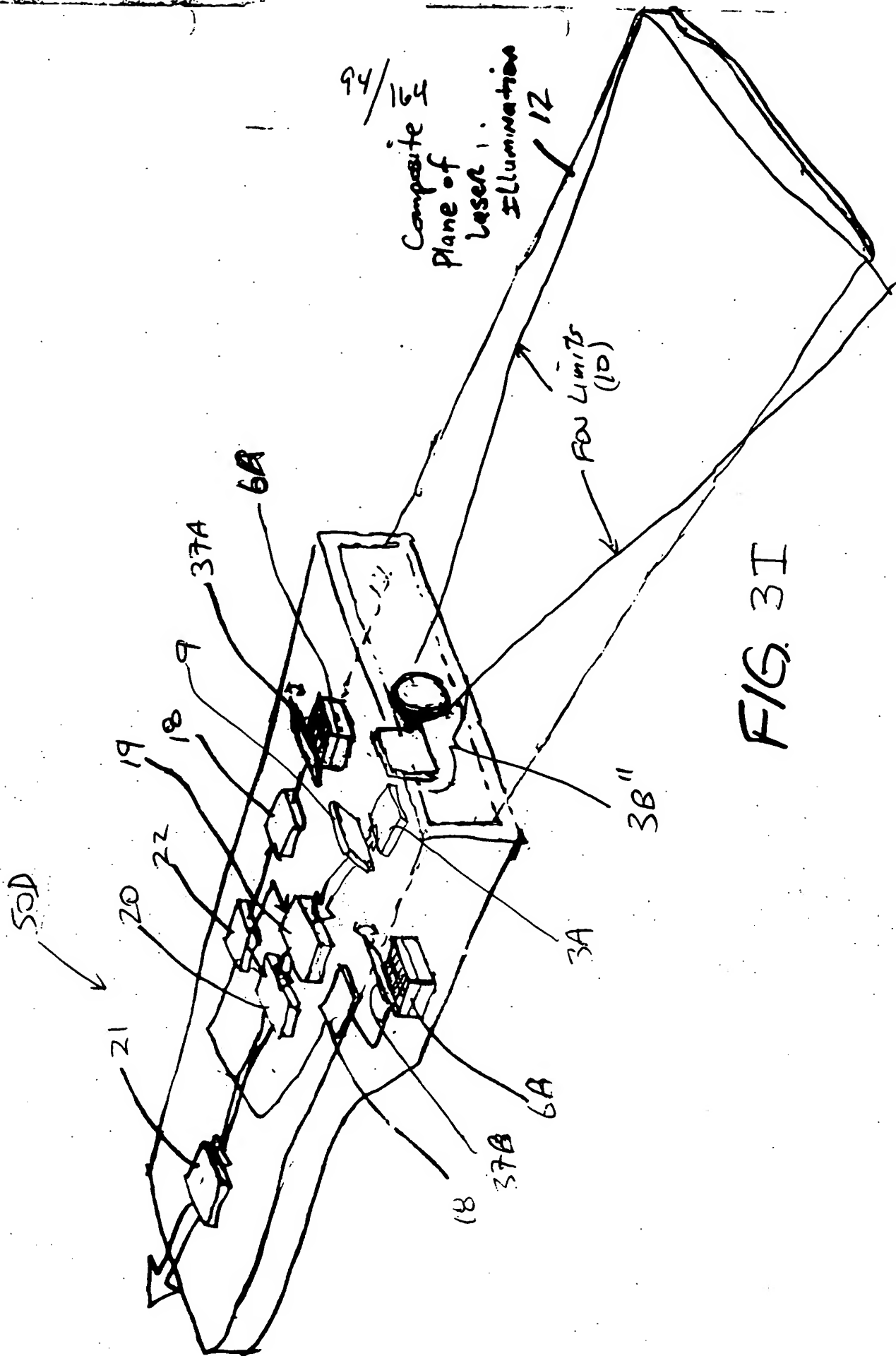


FIG. 3H



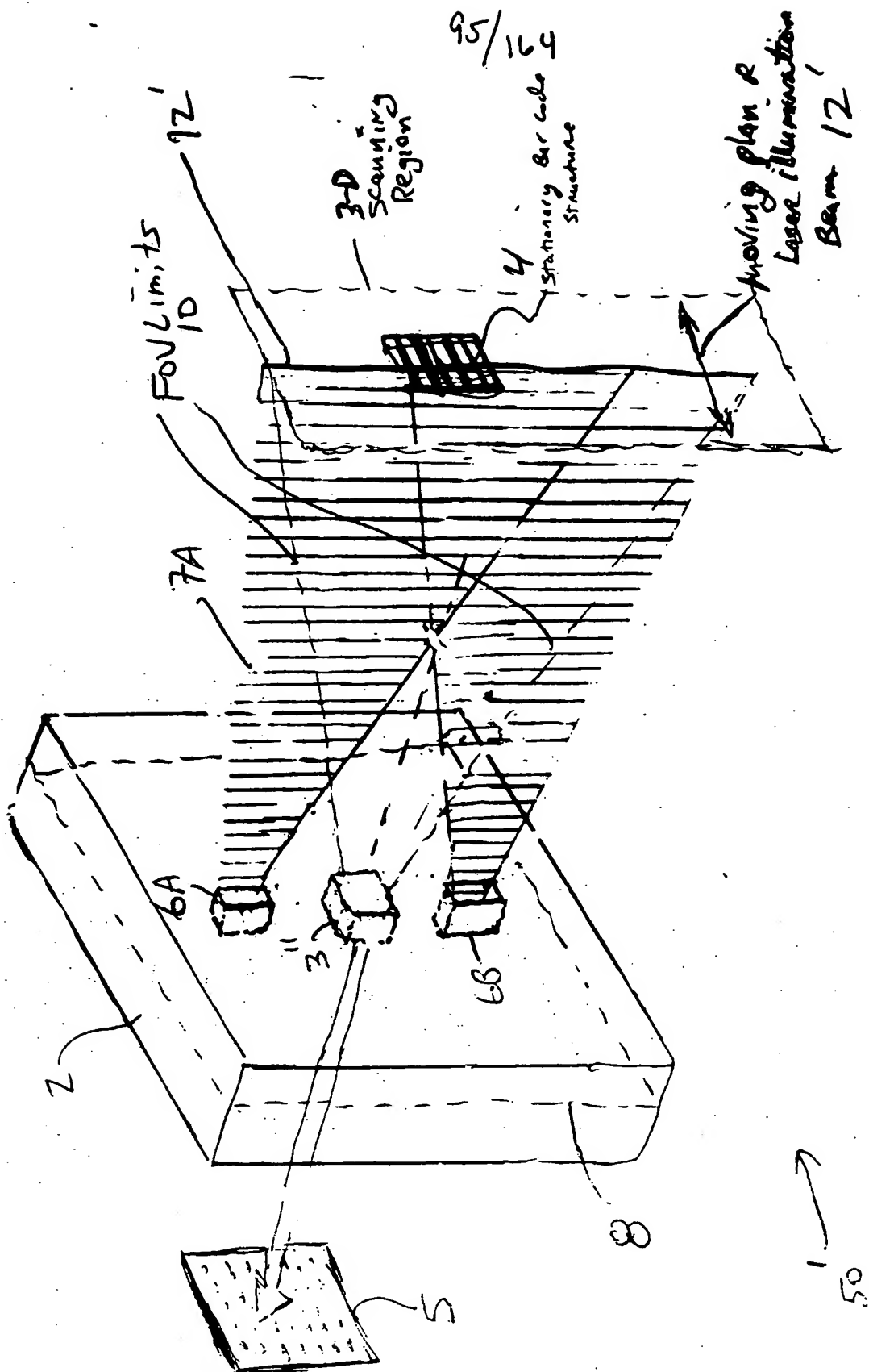


FIG. 3J1

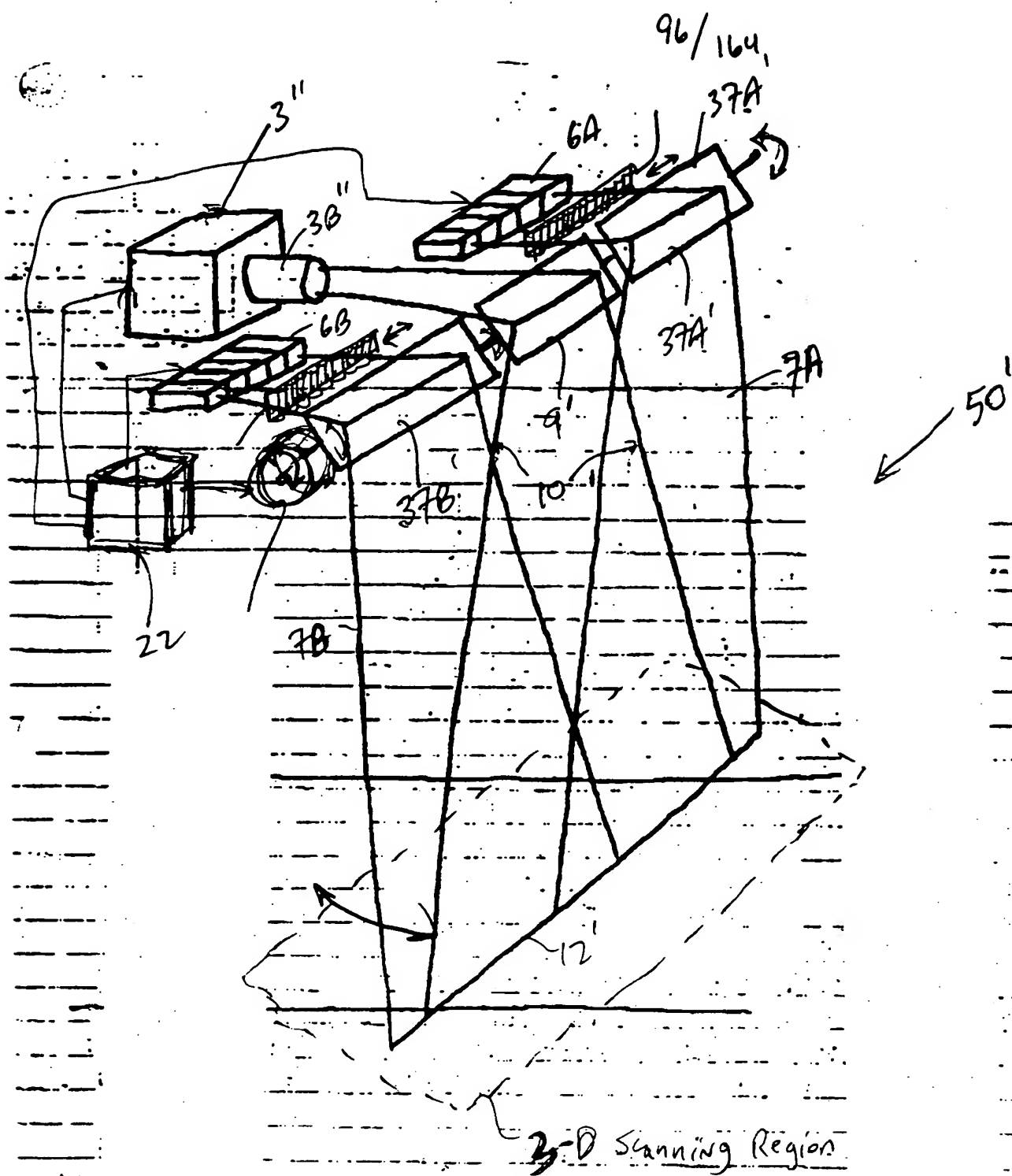


FIG. 3J2

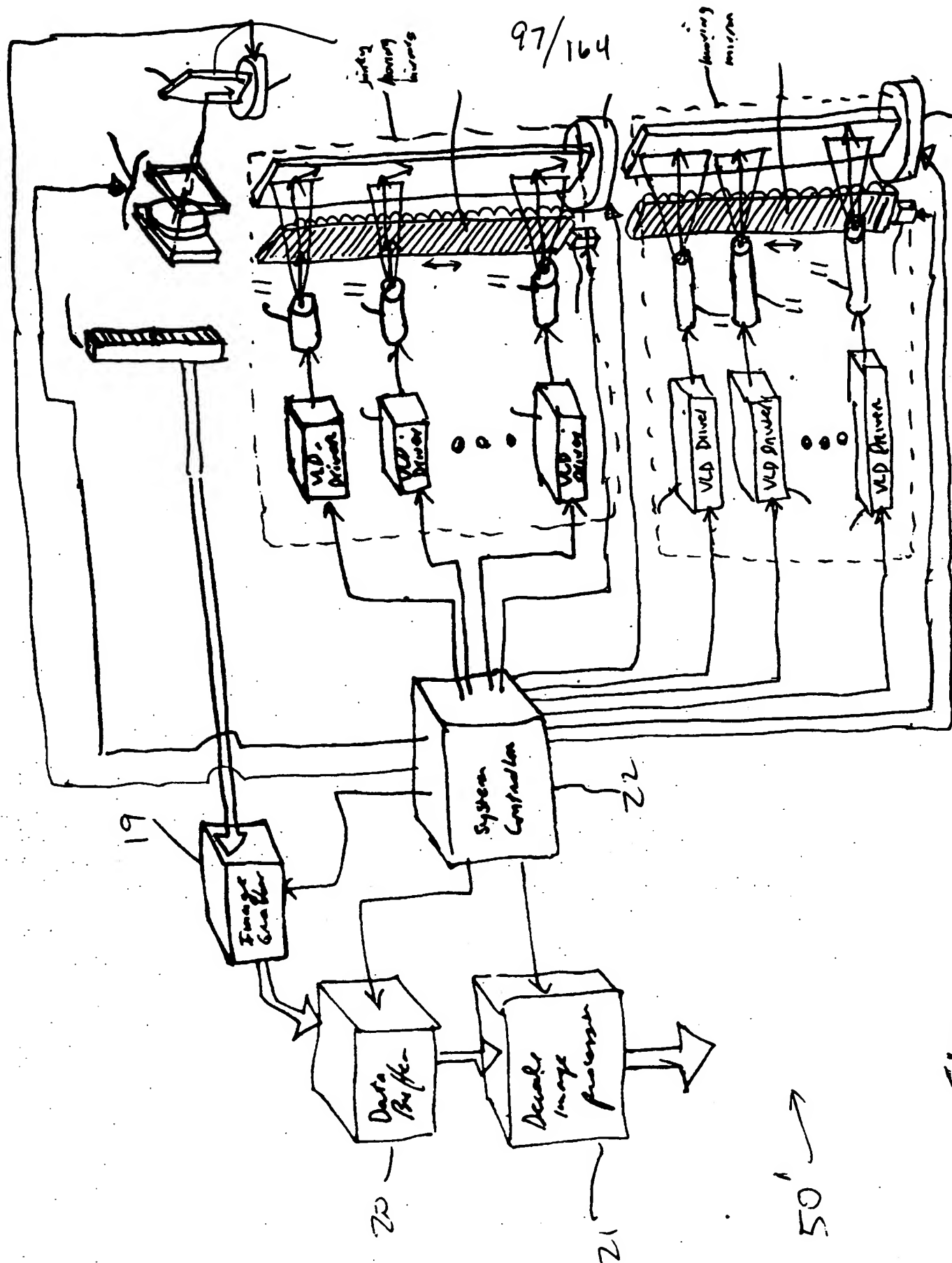


FIG. 3J3

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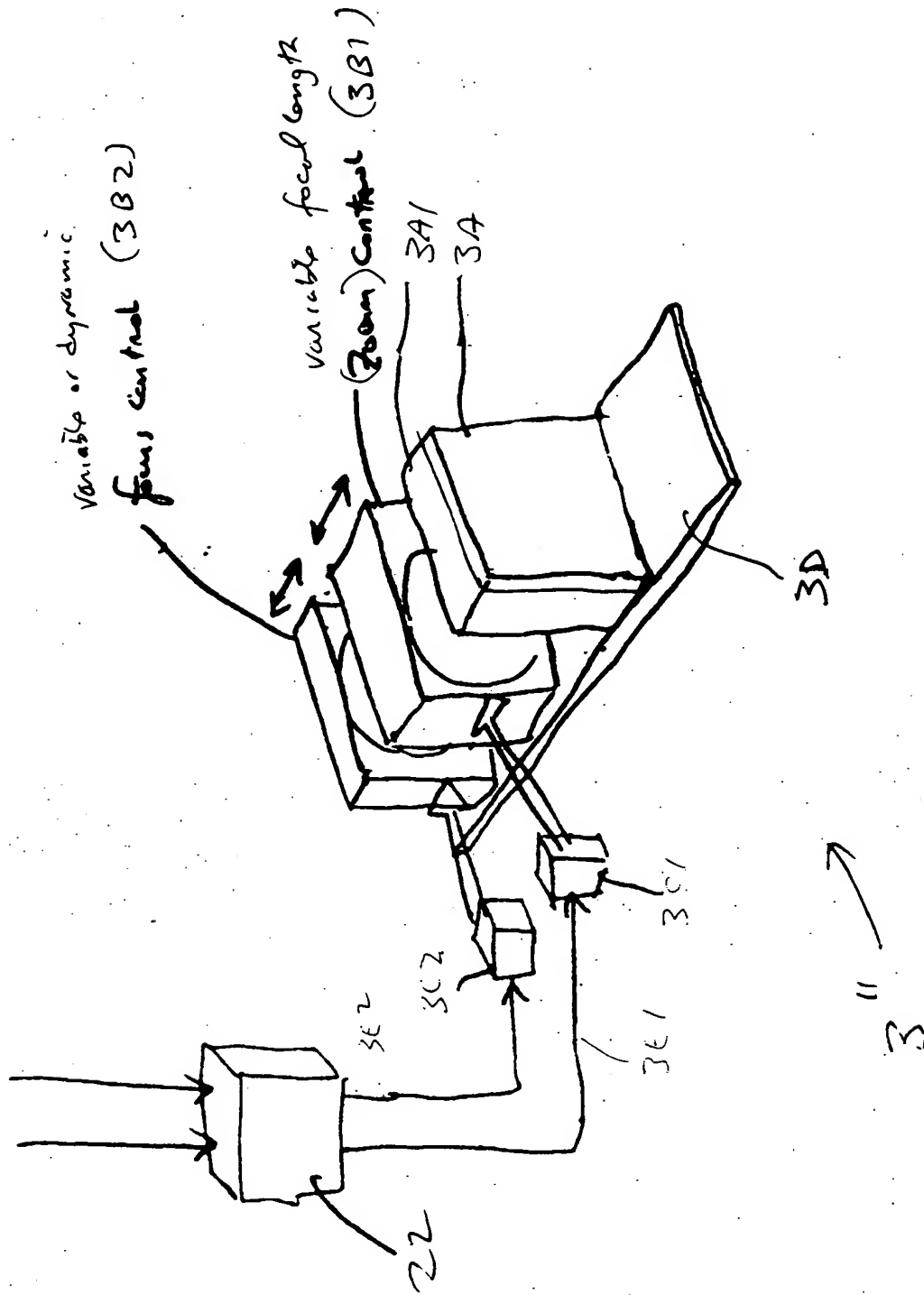
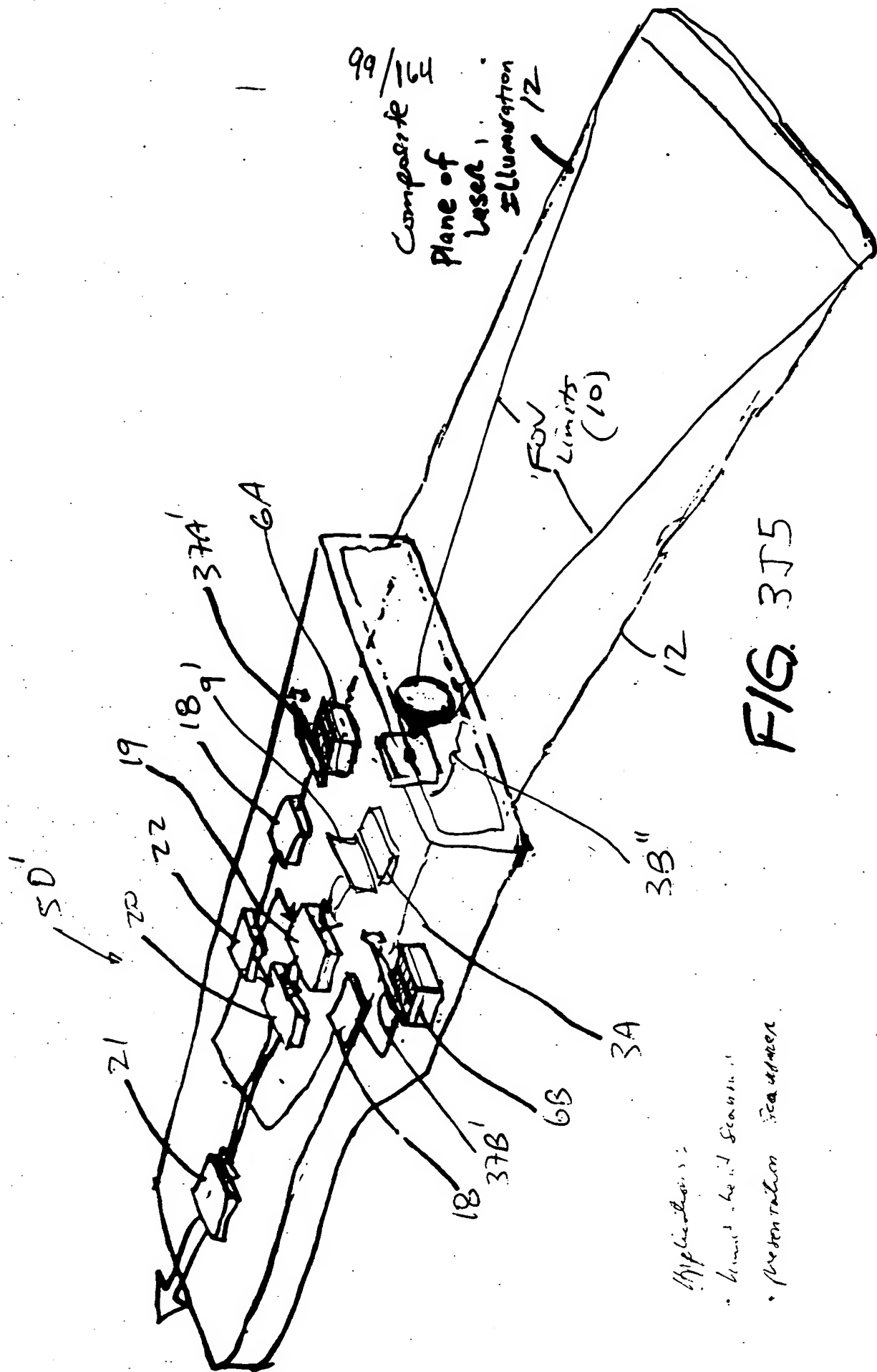


FIG. 354



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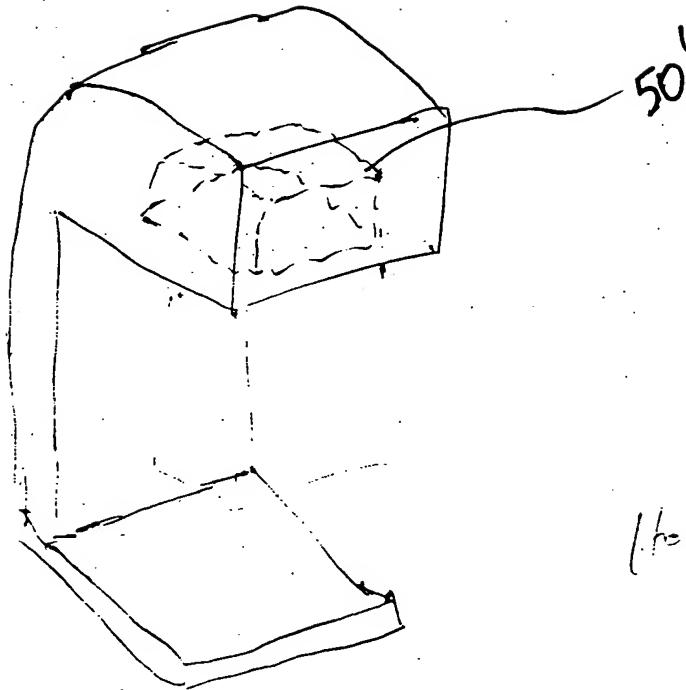
Composite  
Plane of  
Laser  
Illumination

FOV  
Limits  
(10)

FIG. 3J5

Applications:  
• limit beam spread  
• protection features

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2-D  
Hold-up  
Scanner

FIG. 318

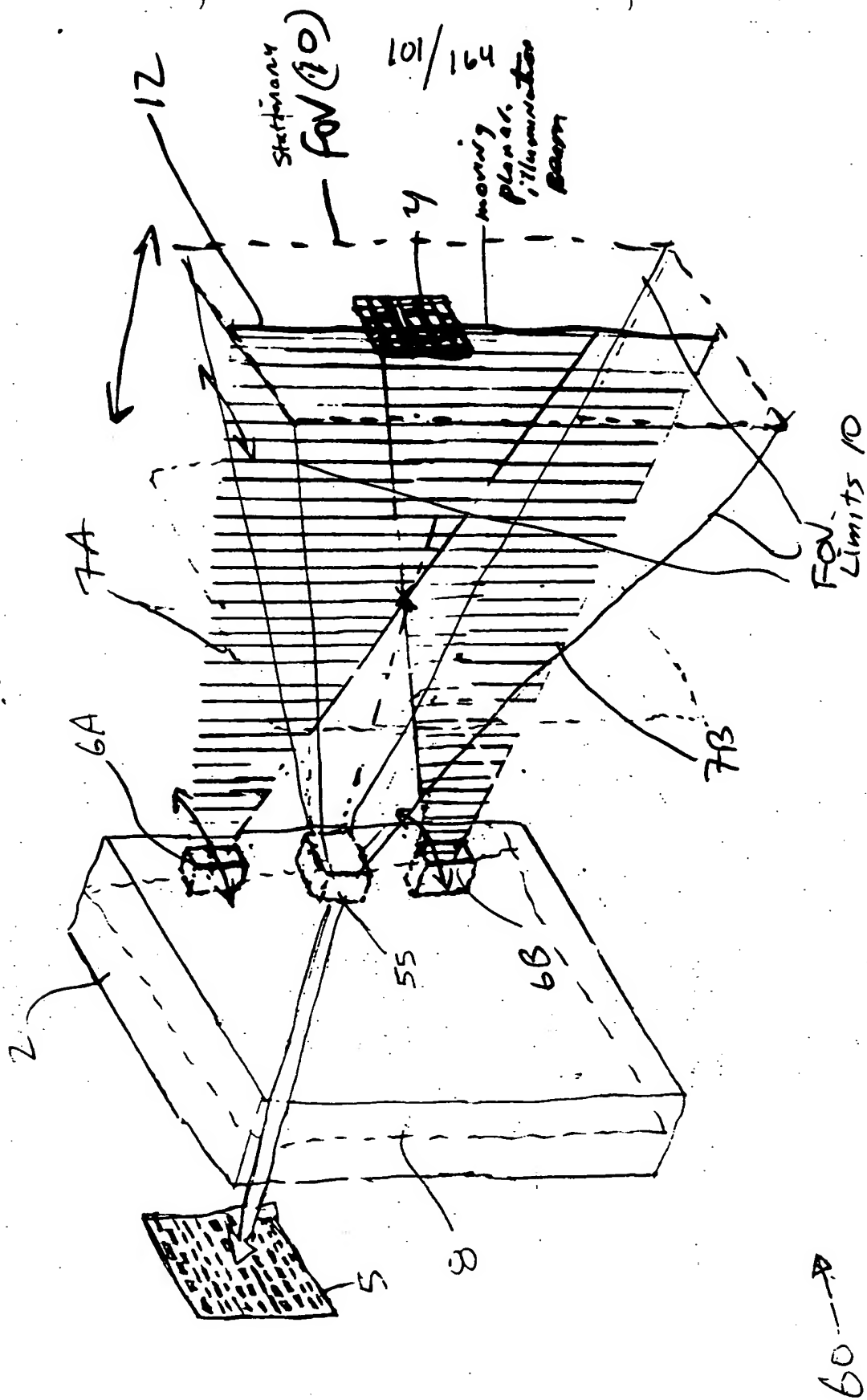


FIG 4A

60 →

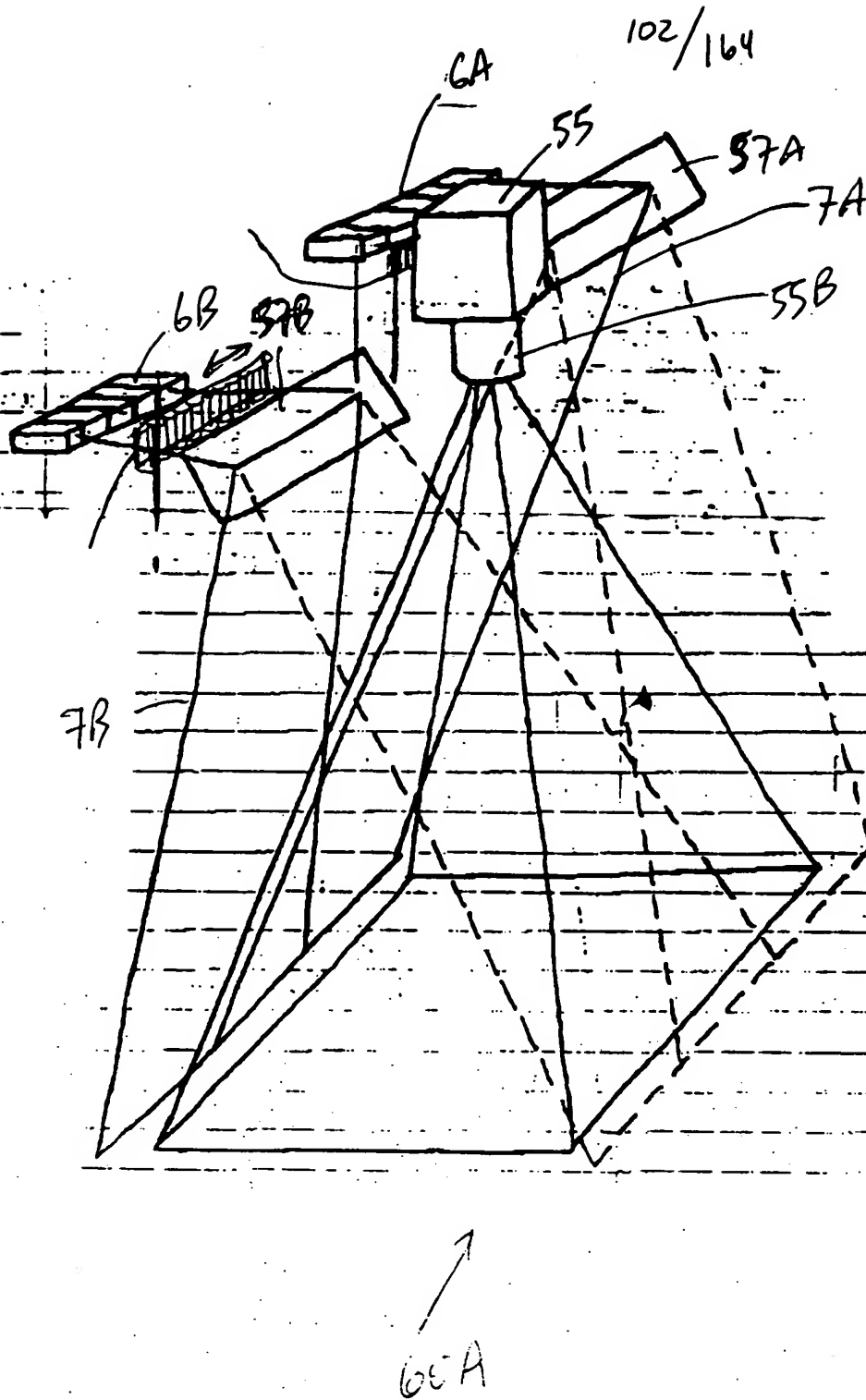


FIG. 4B1

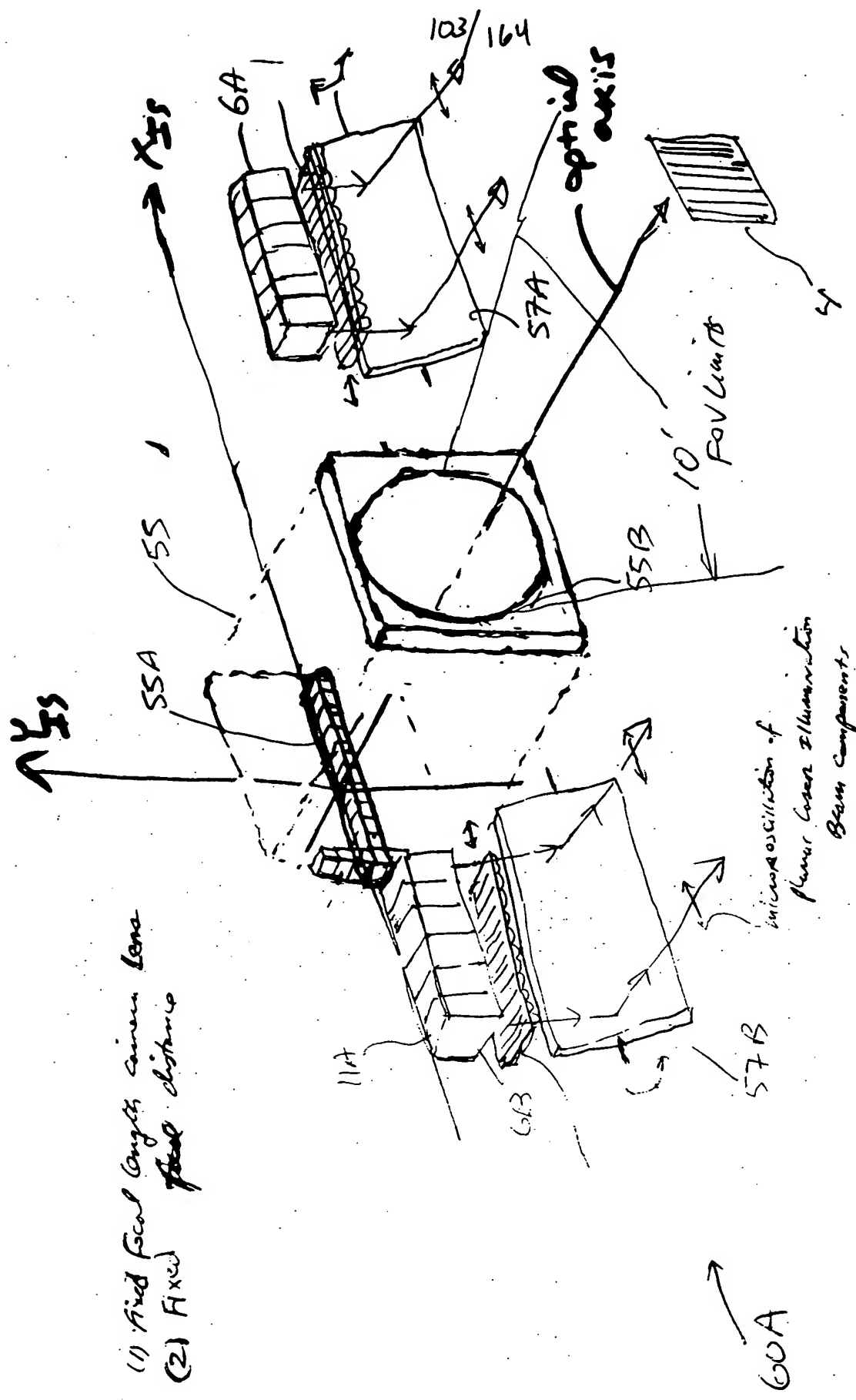
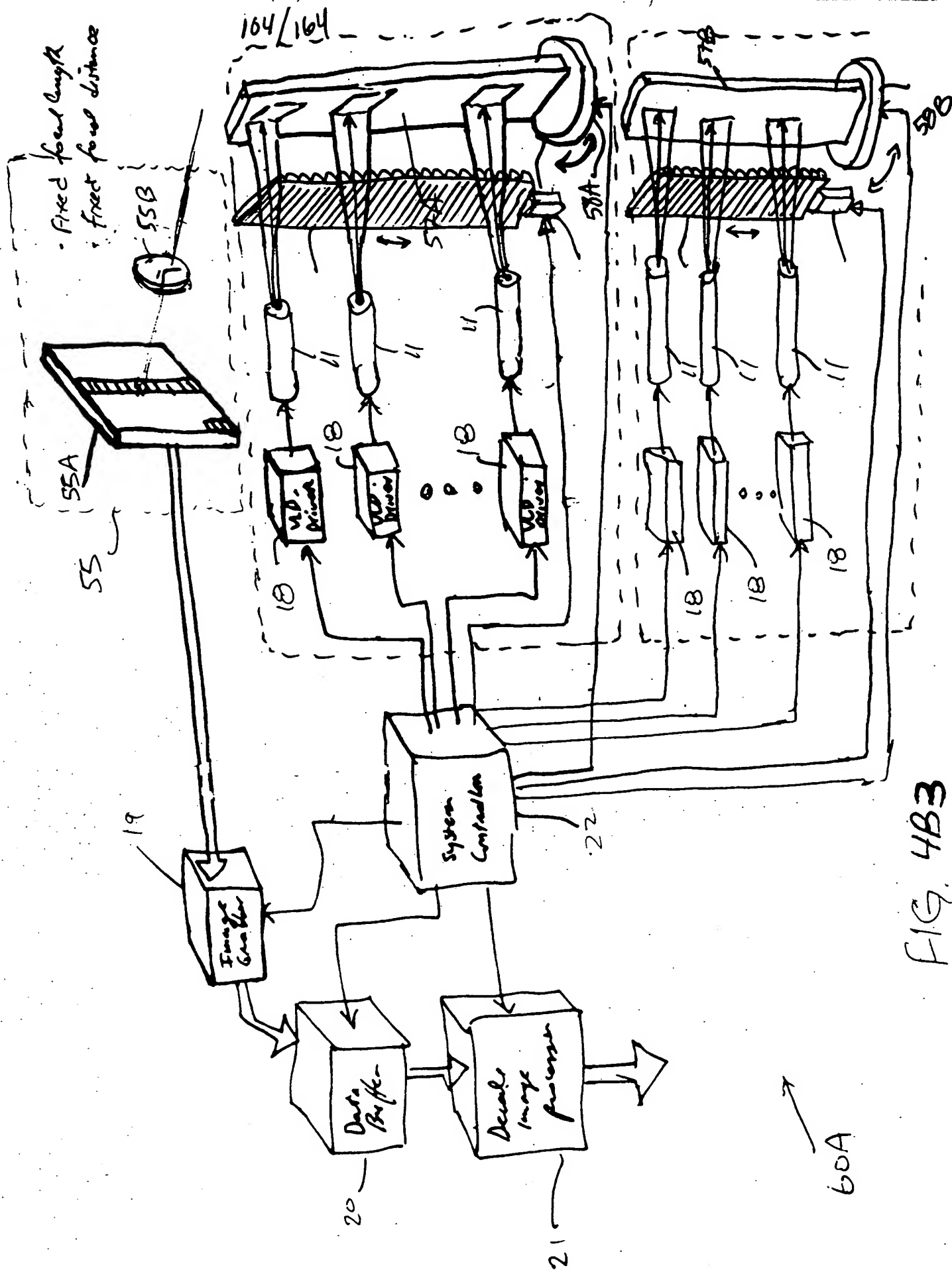


FIG. 4BZ



**Abstract**

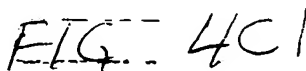
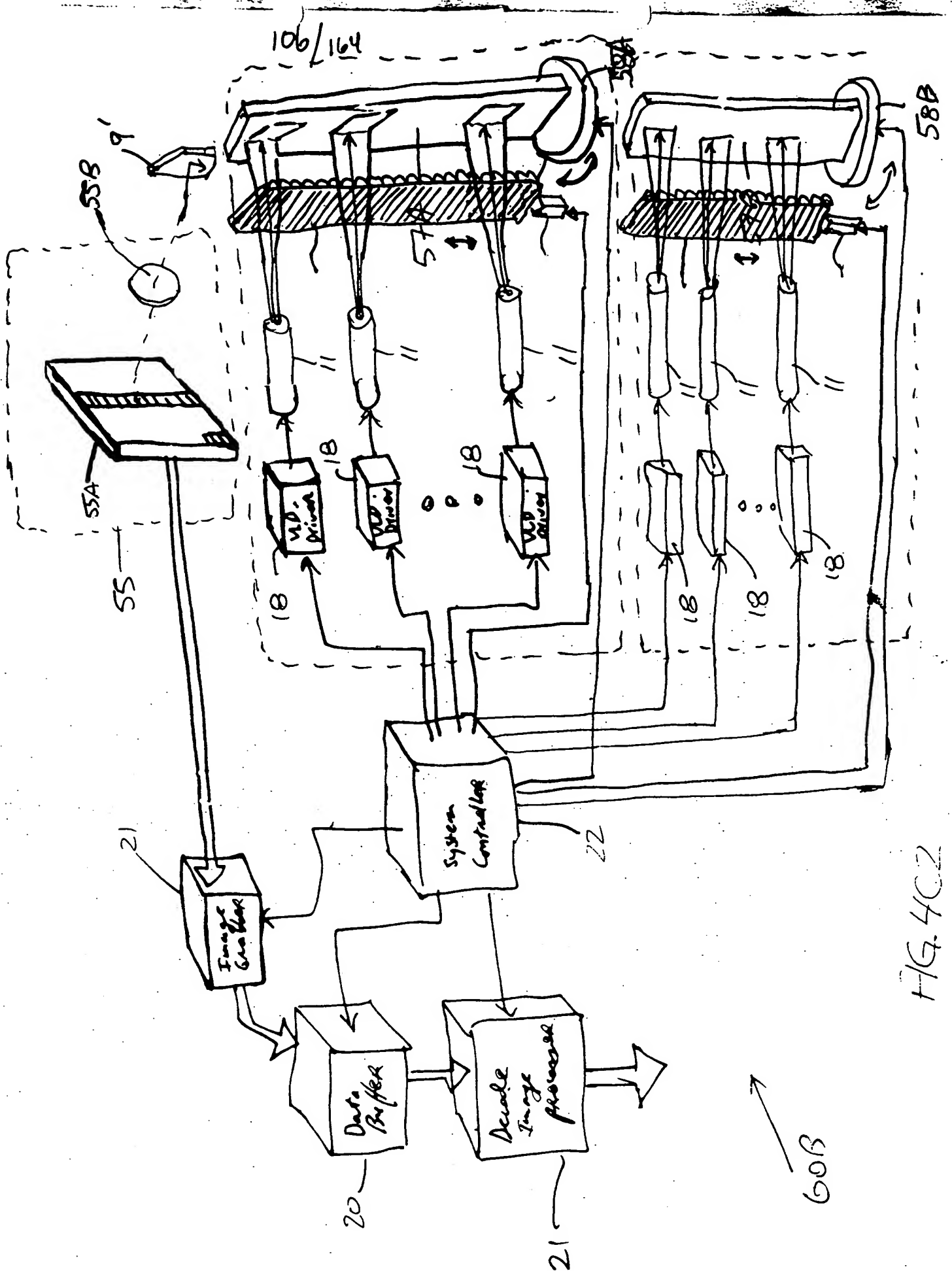


FIG. 4C1



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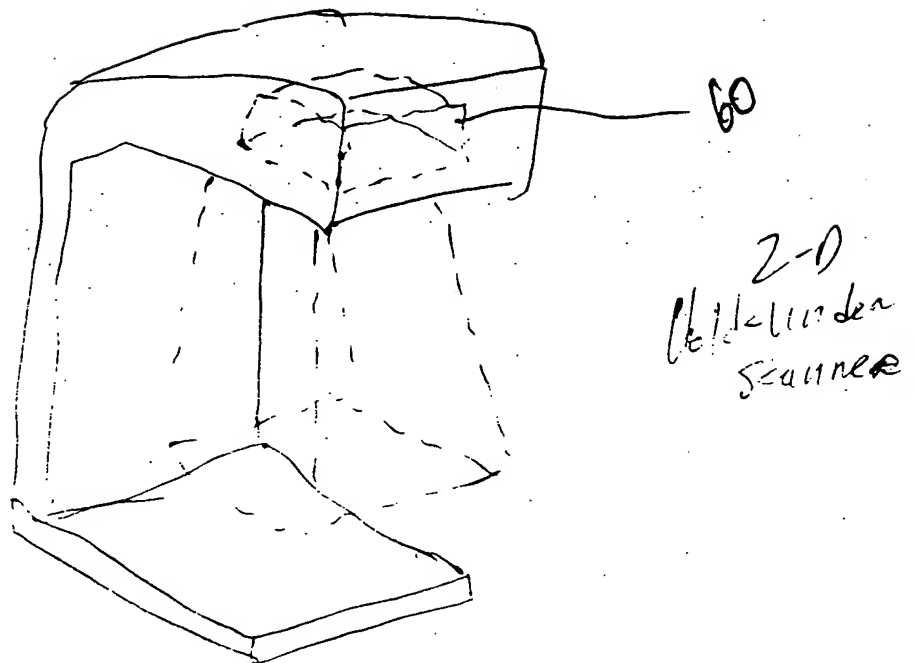


FIG. 4D

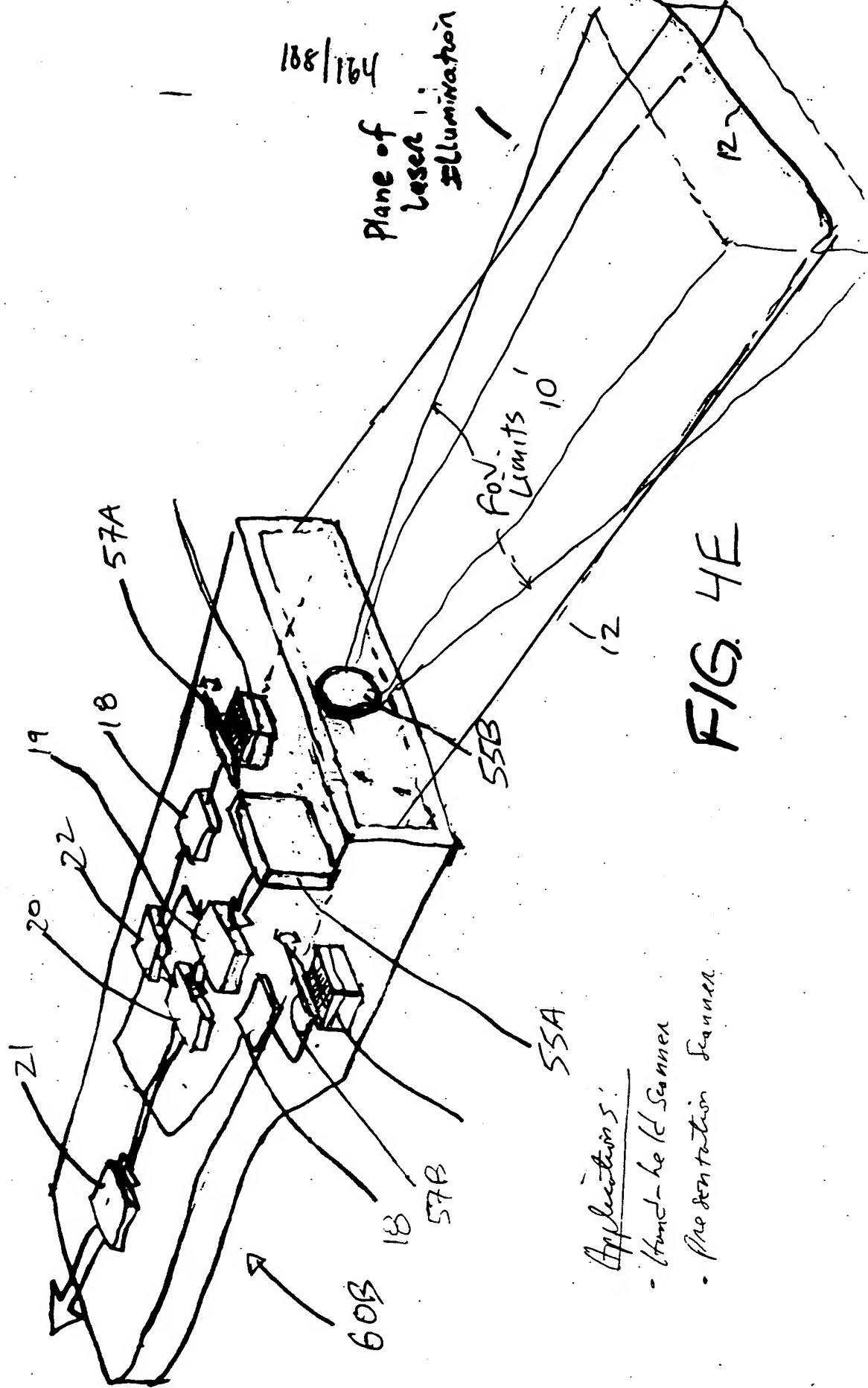
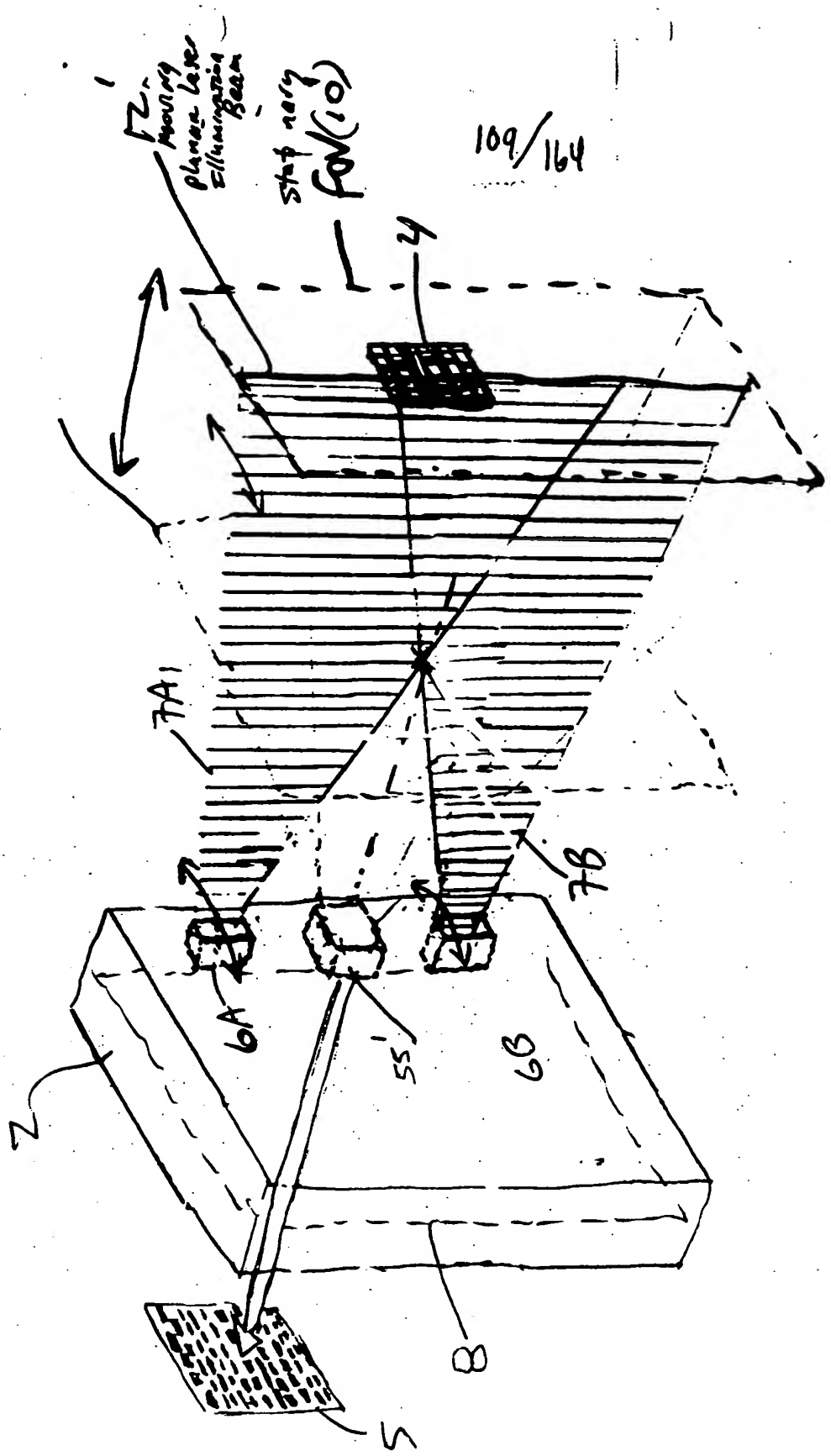


FIG. 4E

Applications:

- Hand-held Scanner
- Presentation Scanner



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FIG. 5A

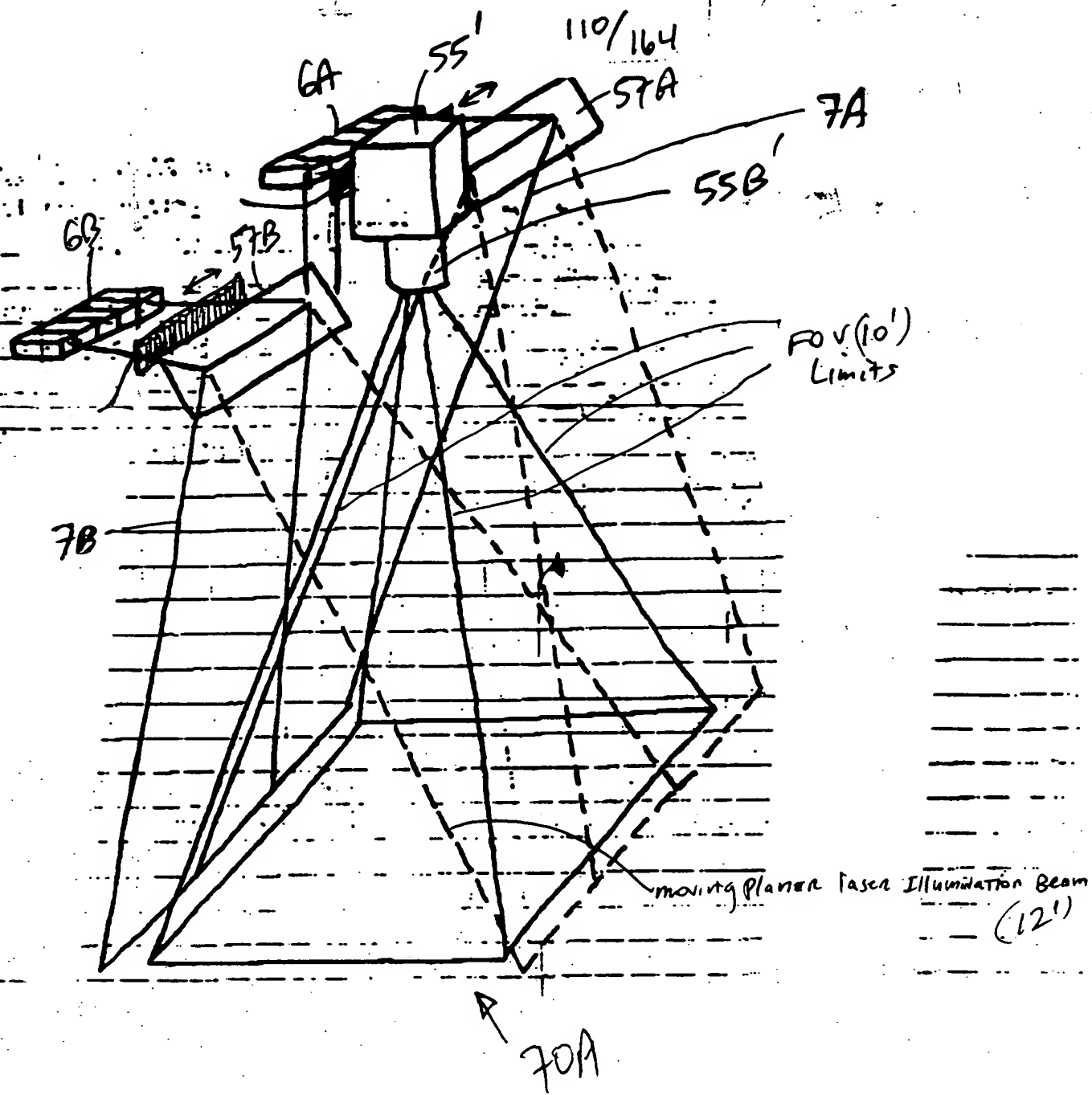
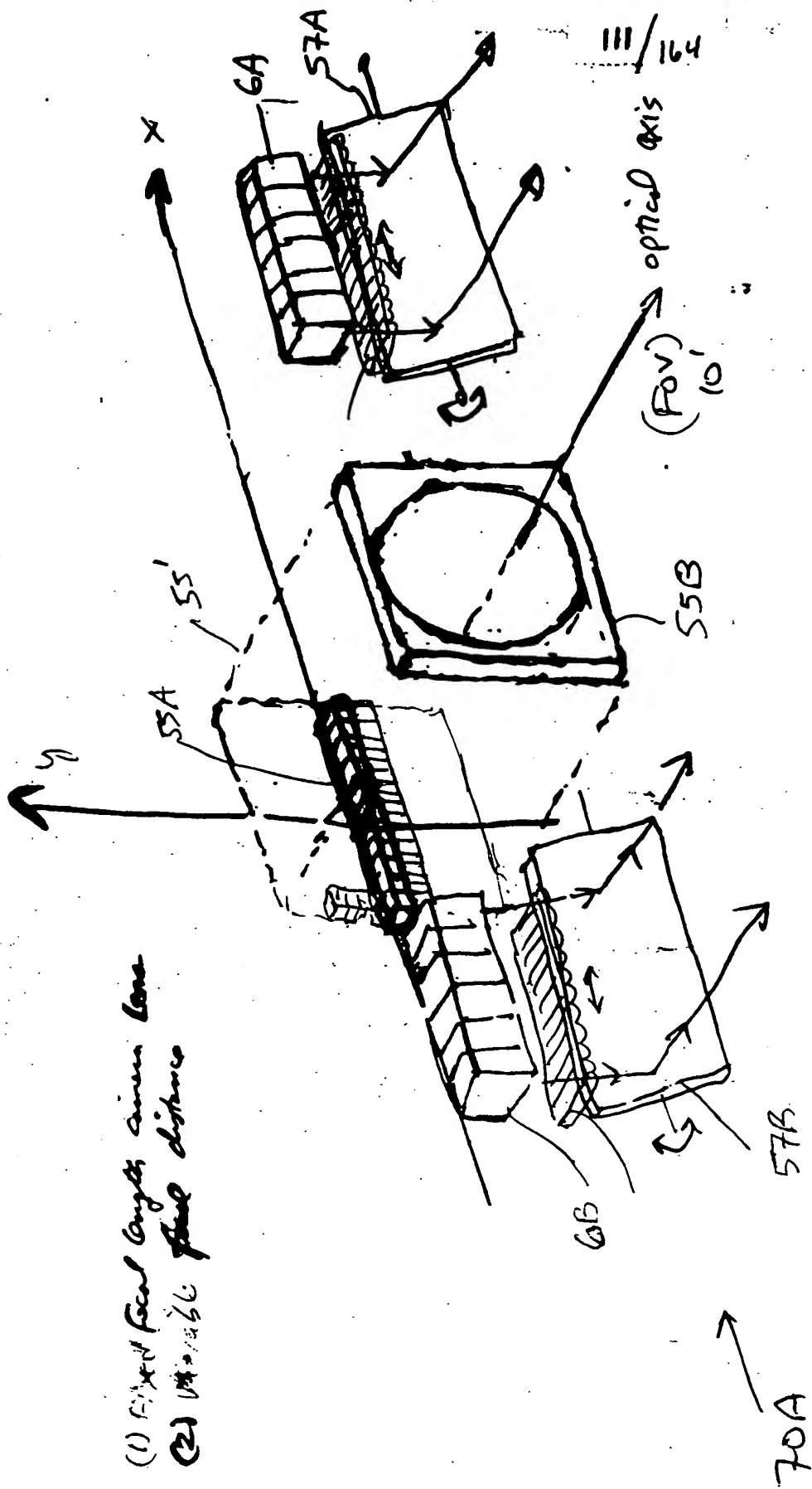


FIG. 5B1



- (1) Fixed focal length camera lens
- (2) Variable focal distance

FIG. 5B2

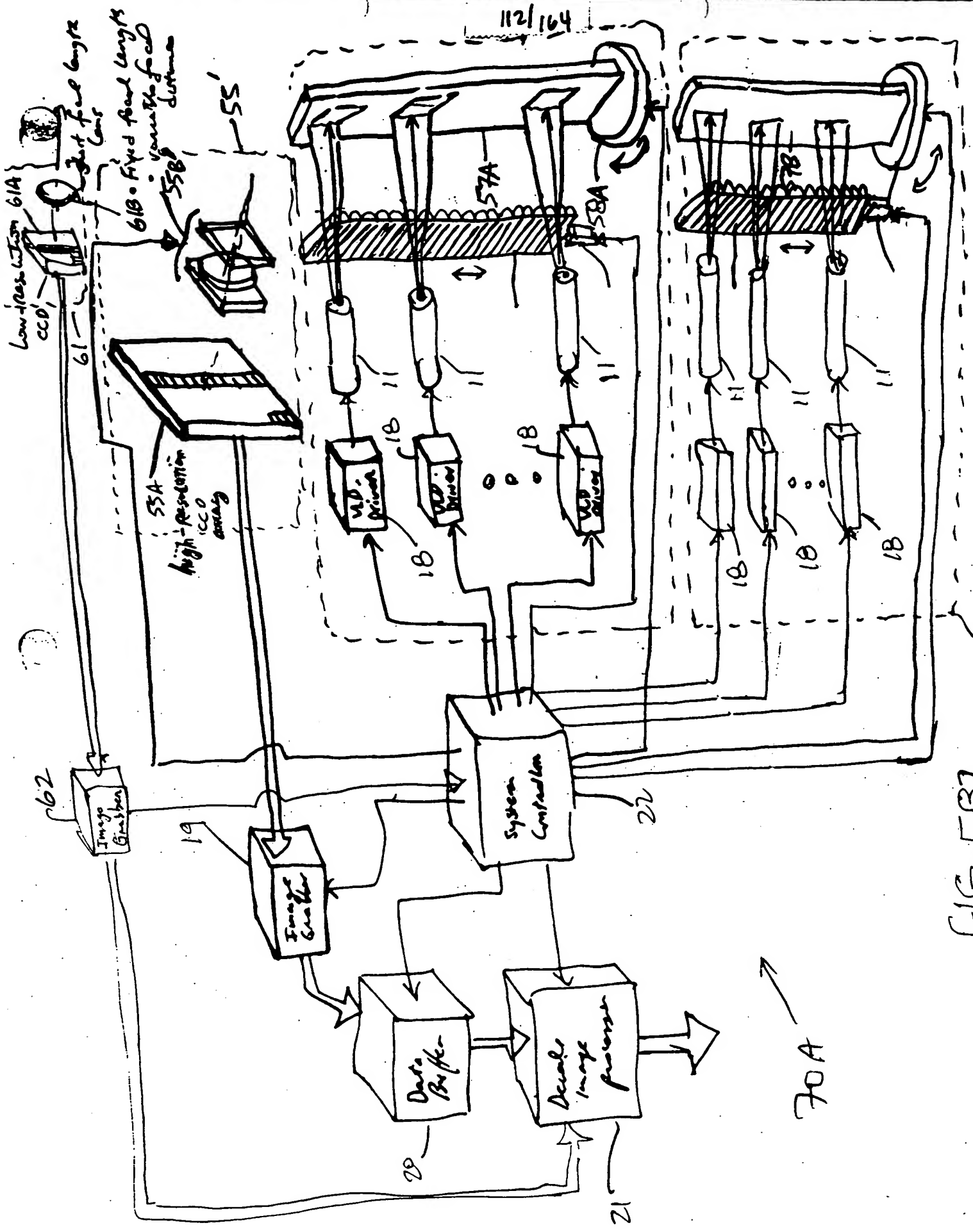
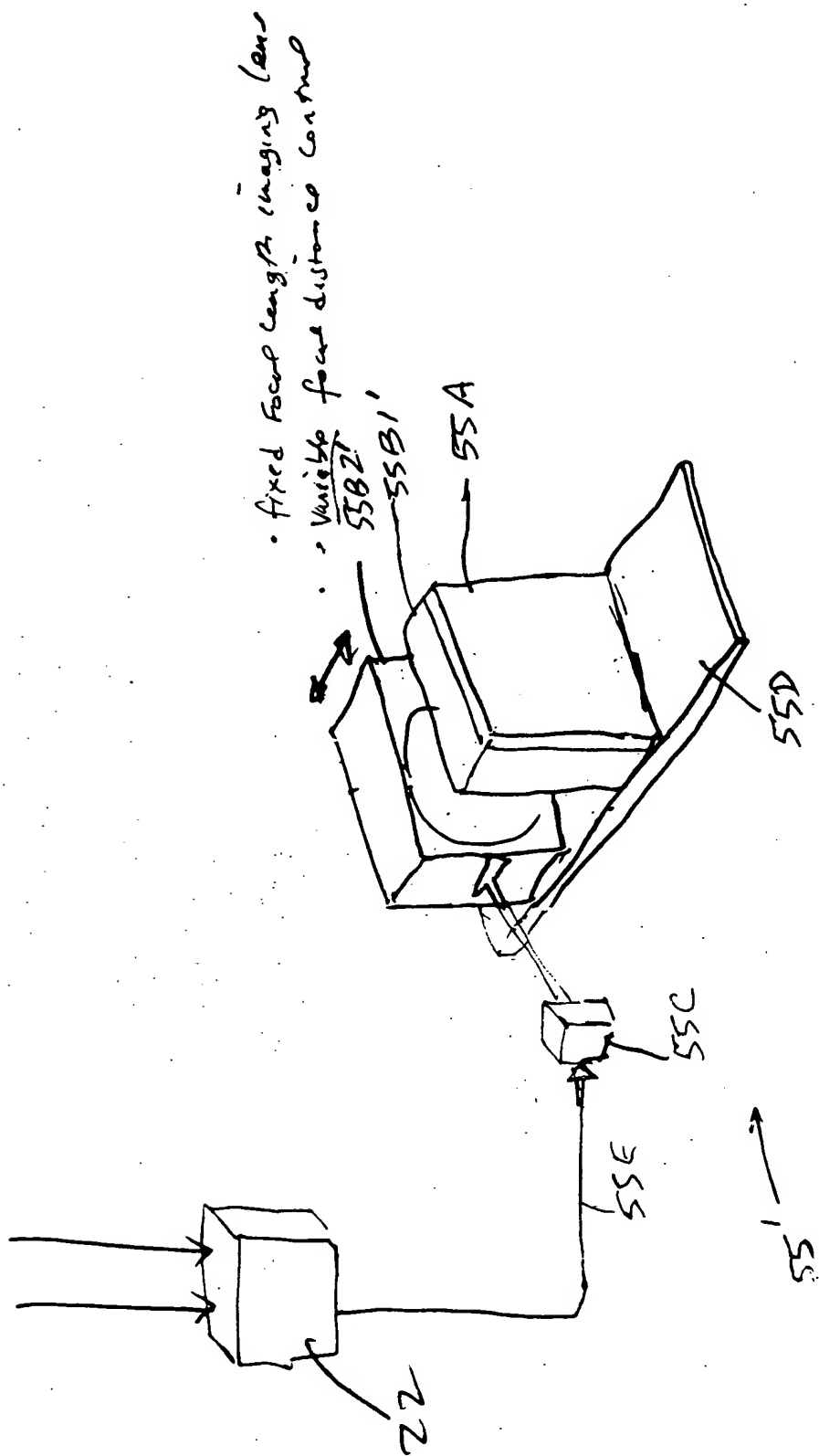


FIG. 5B3

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• fixed focal length imaging lens  
• Variable focus distance control

FIG. 5B4

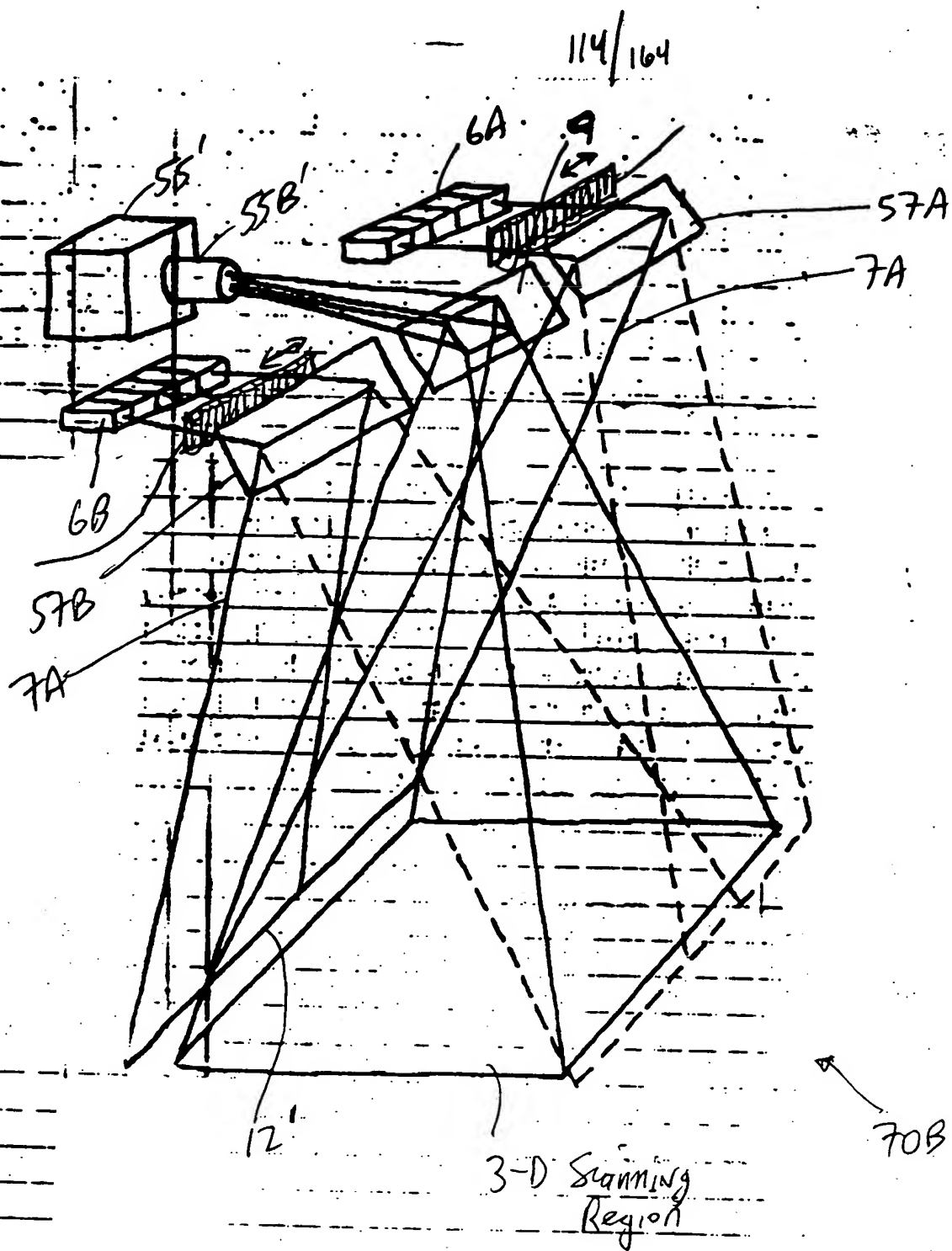


FIG. 5C1

- (1) Variable focal length camera lens  
(2) Fixed focal distance

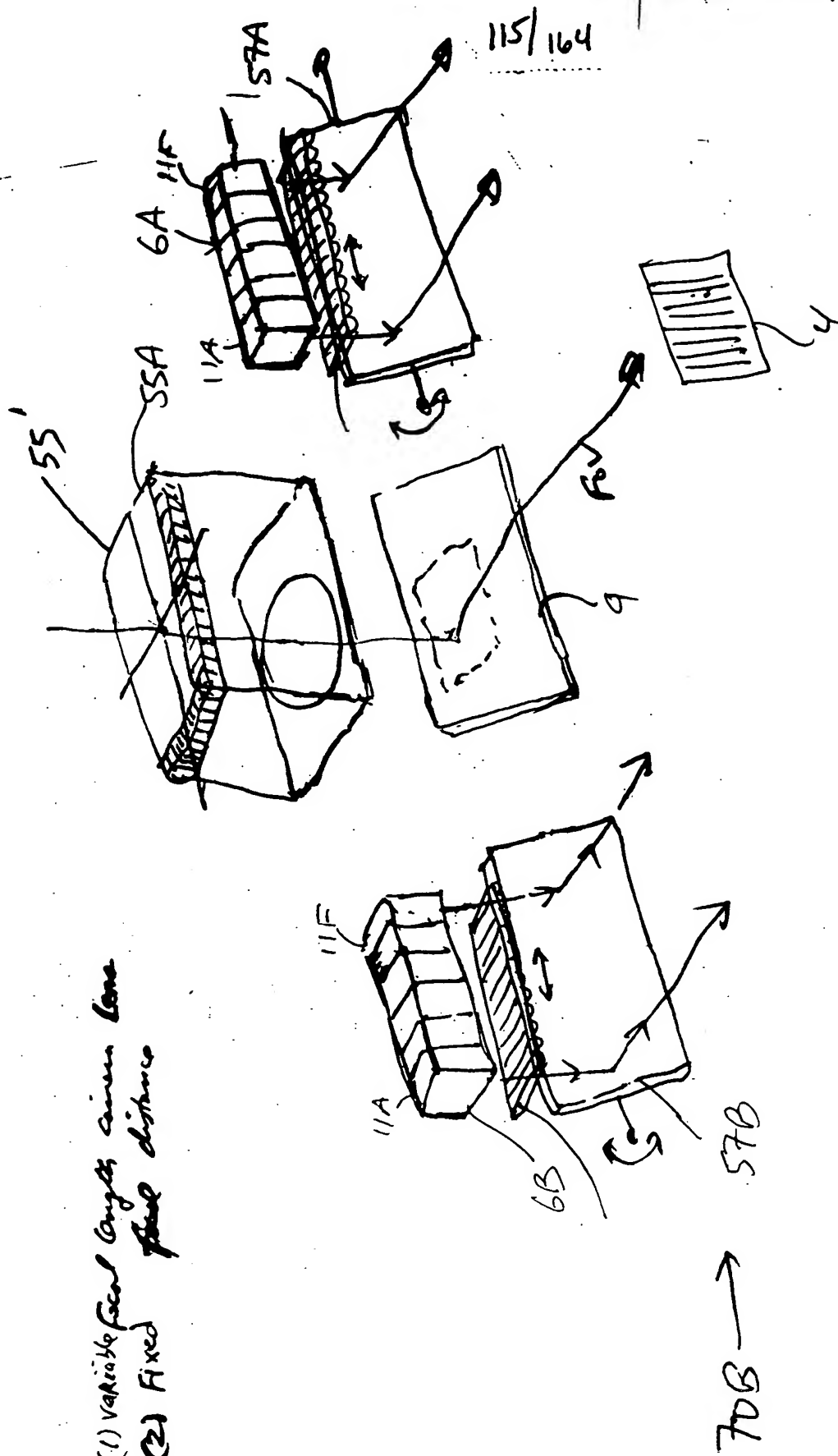
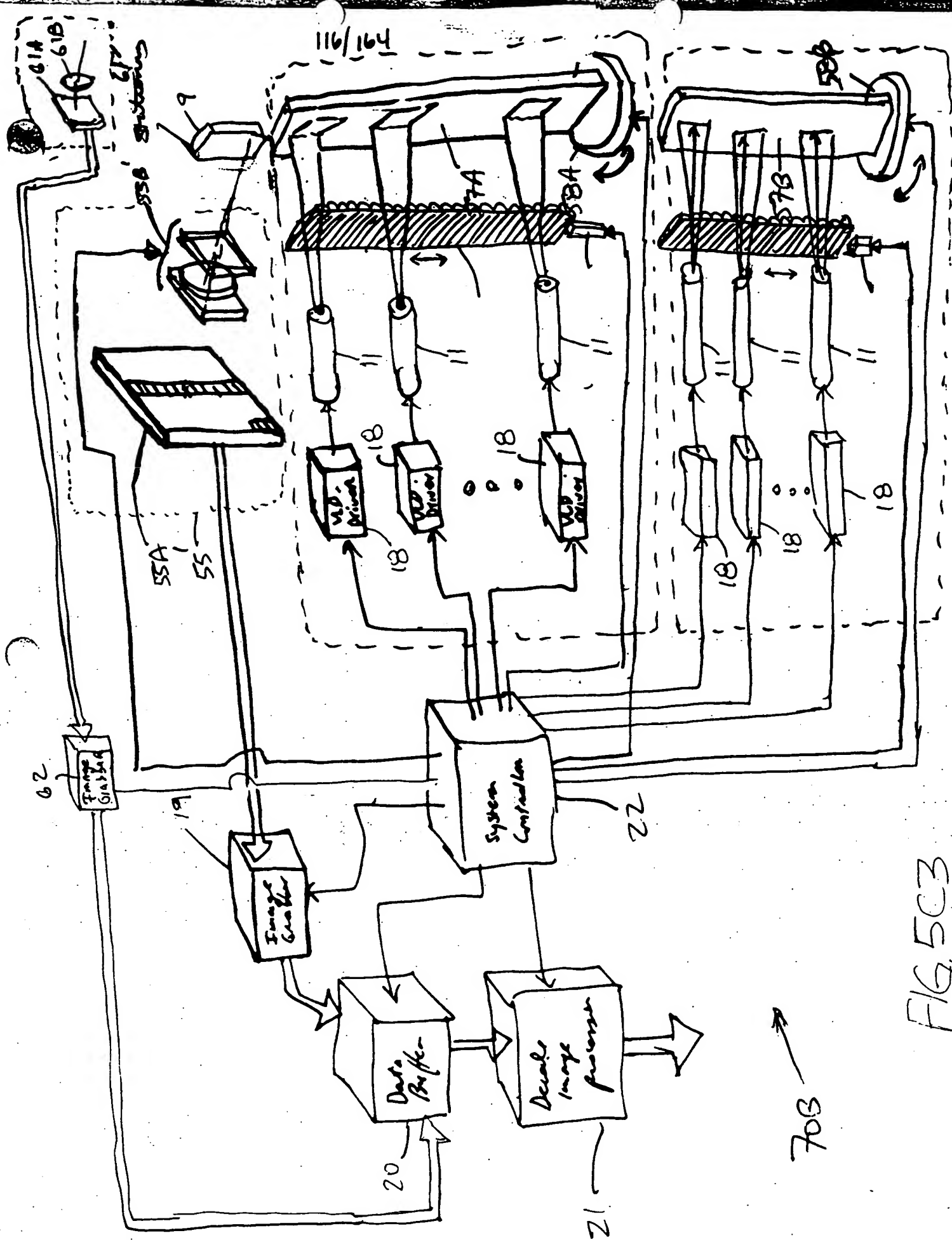


FIG. 502



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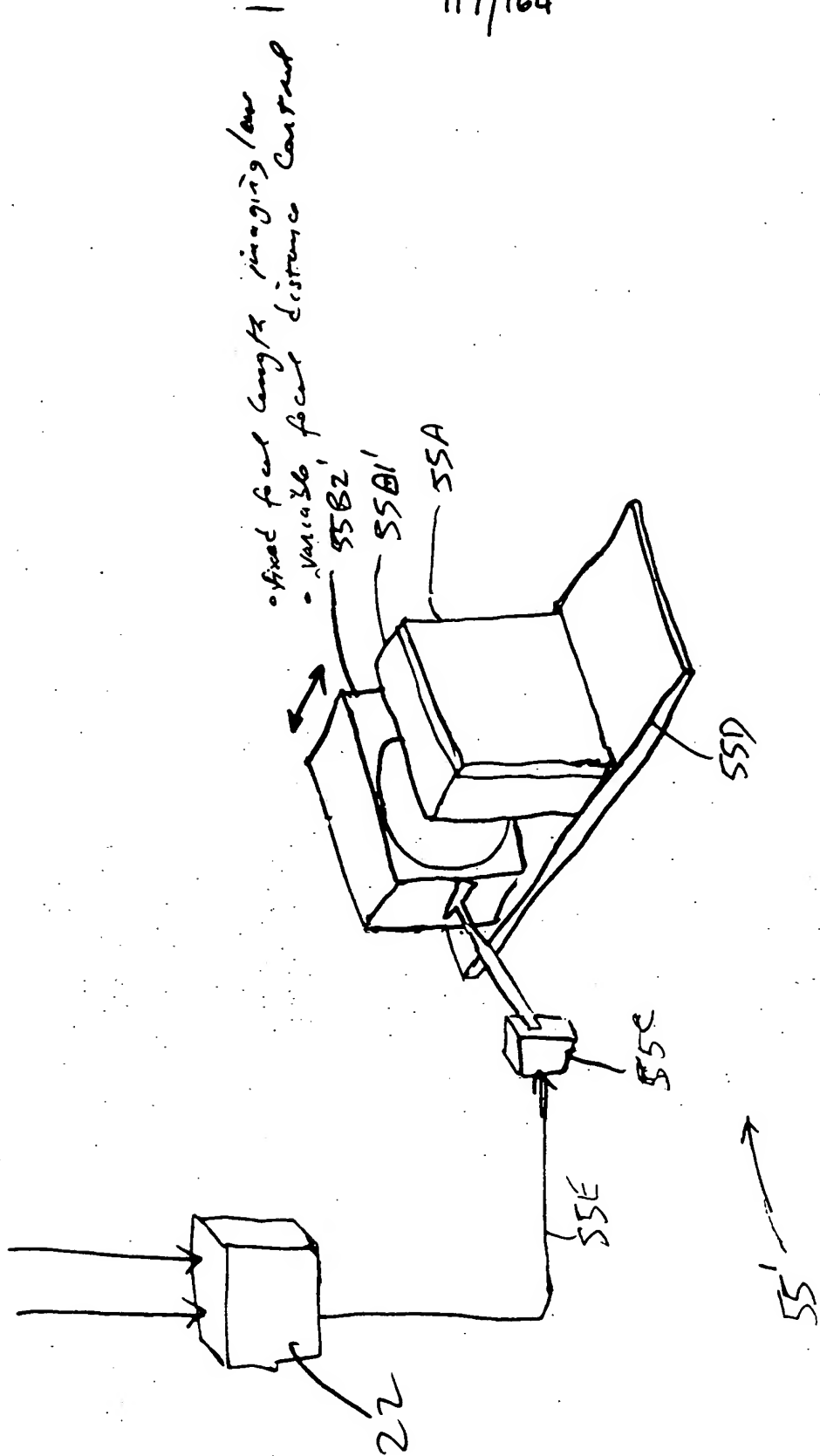


FIG. 5C4

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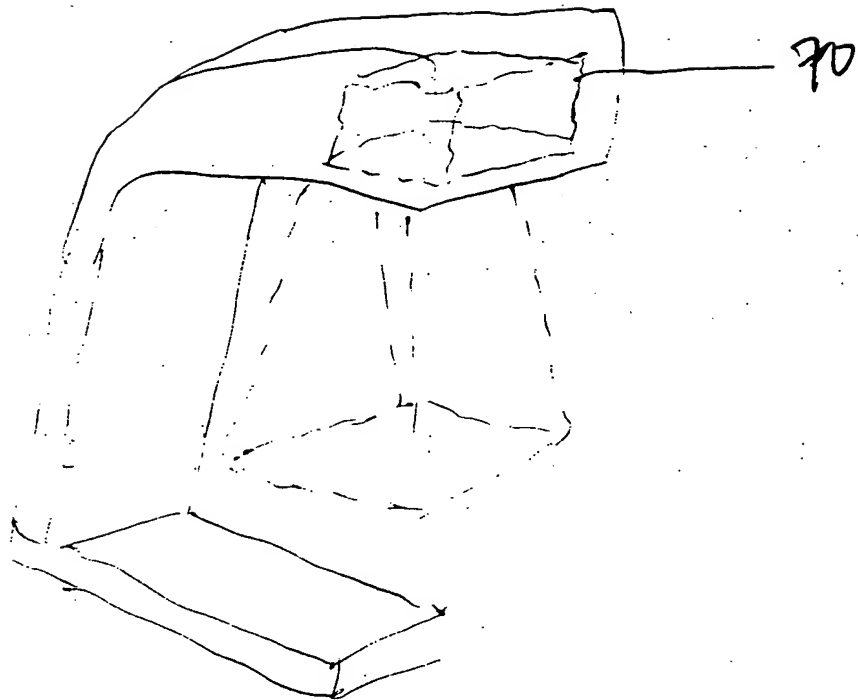


FIG. 5D

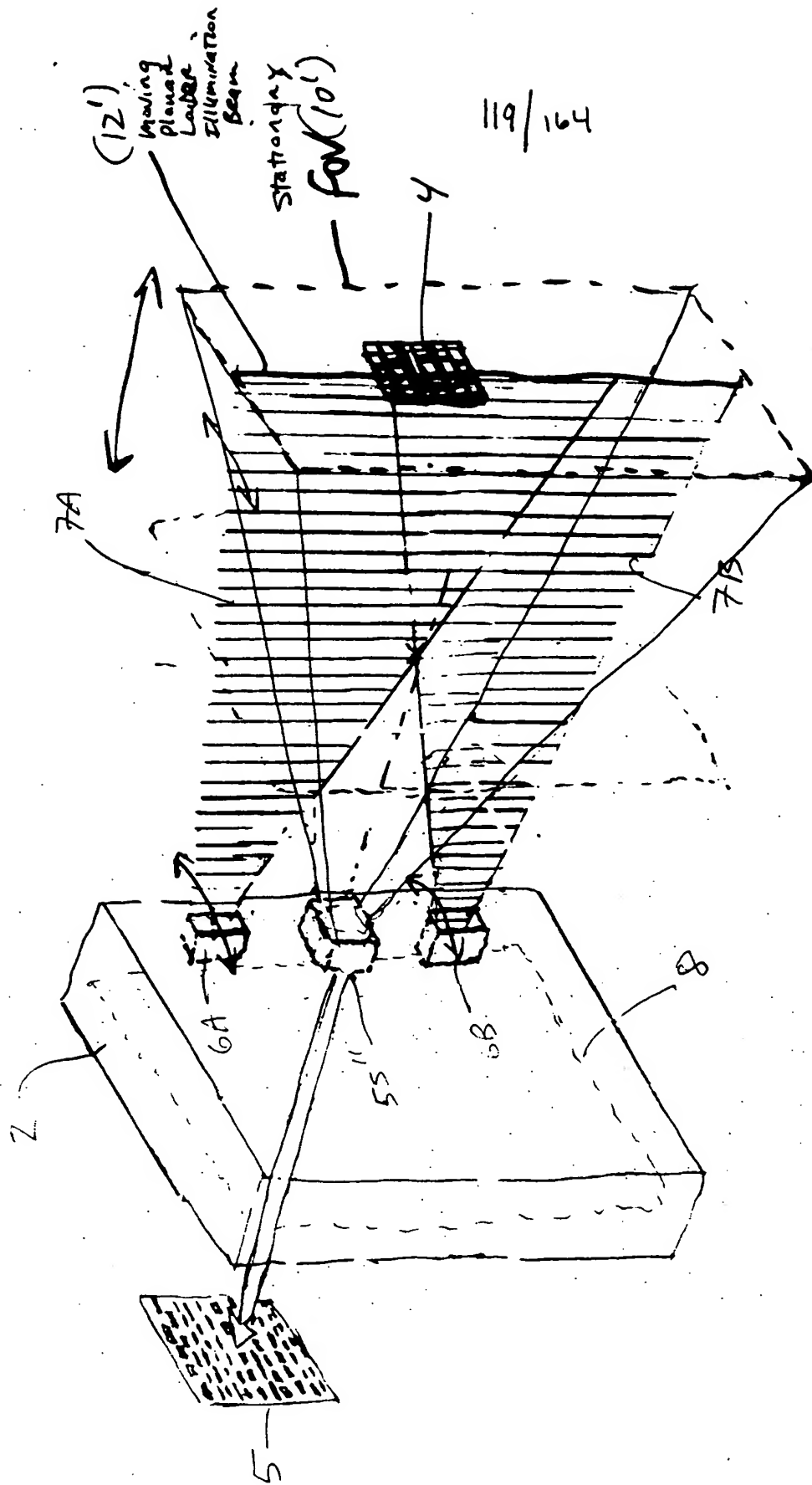


FIG. 6A

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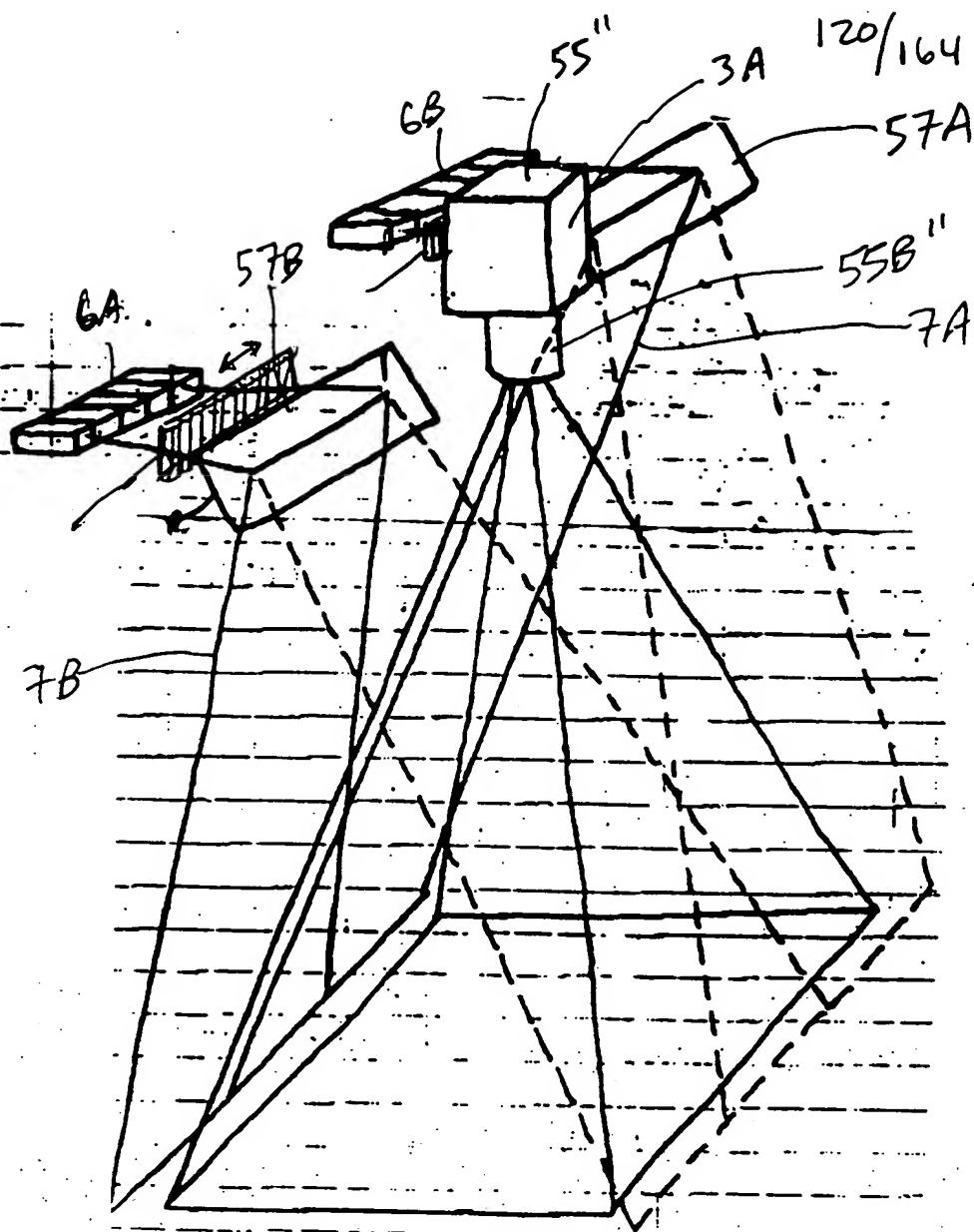
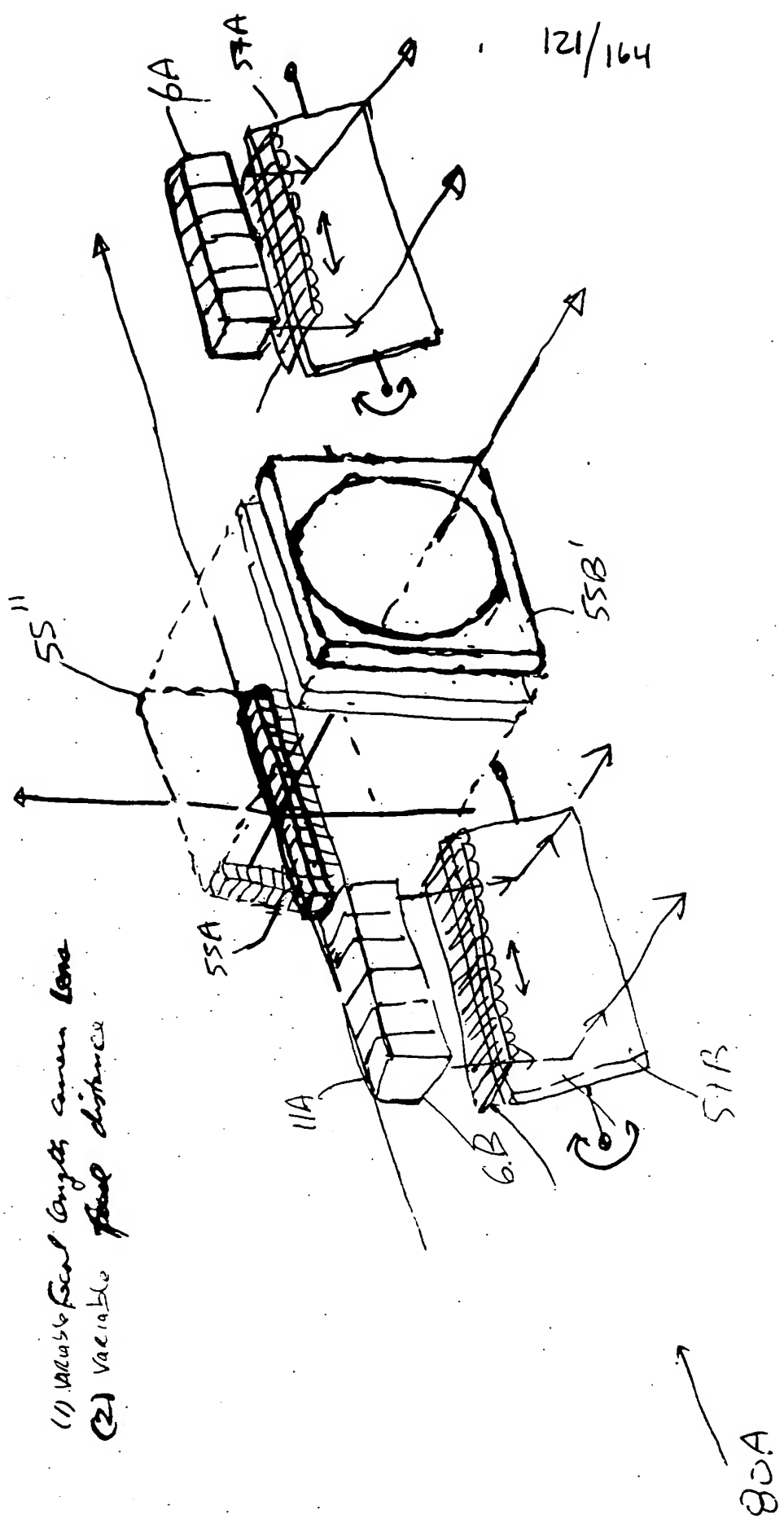
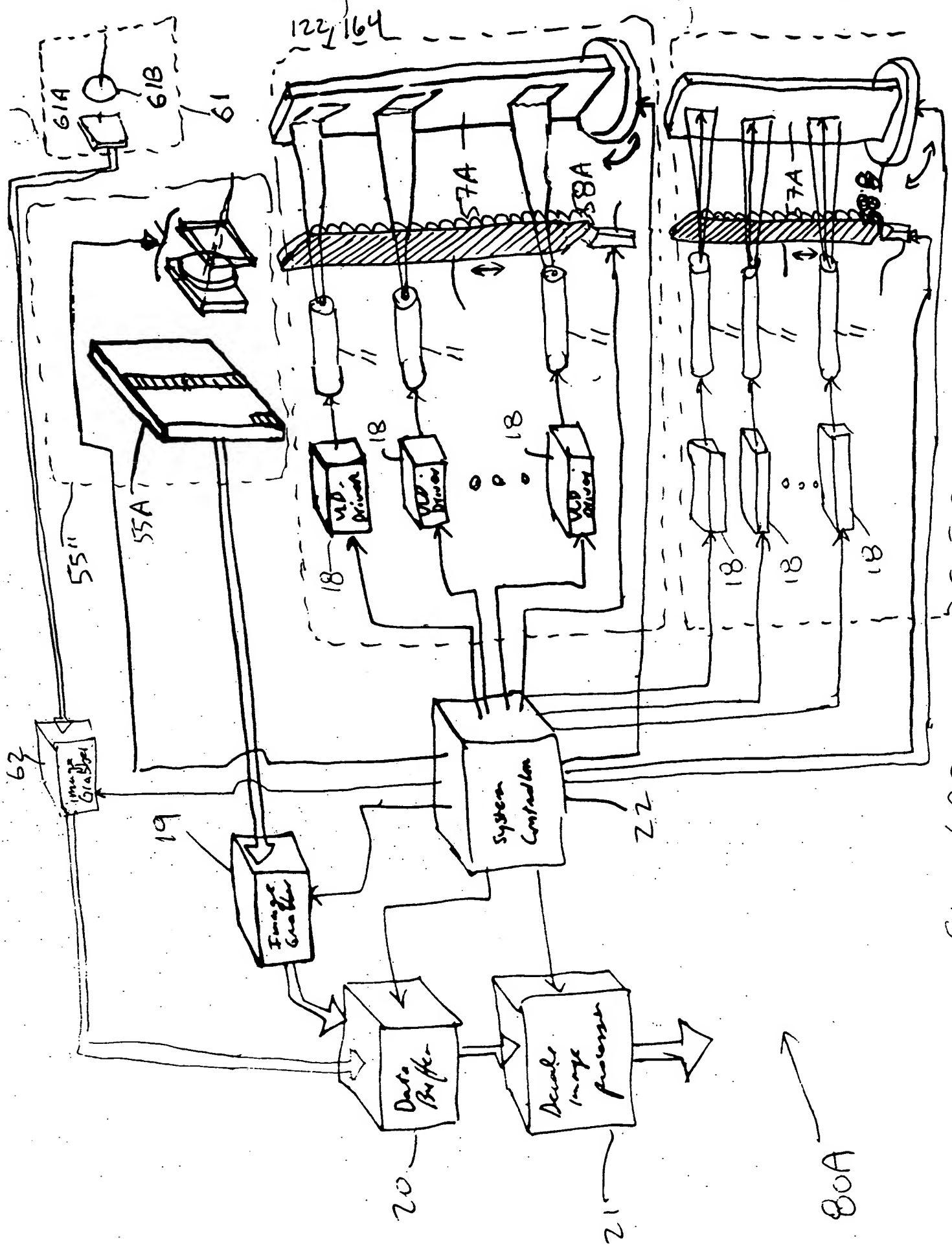


FIG. 6B1



- (1) Variable focal length camera lens
- (2) Variable focal distance

FIG. 6B2



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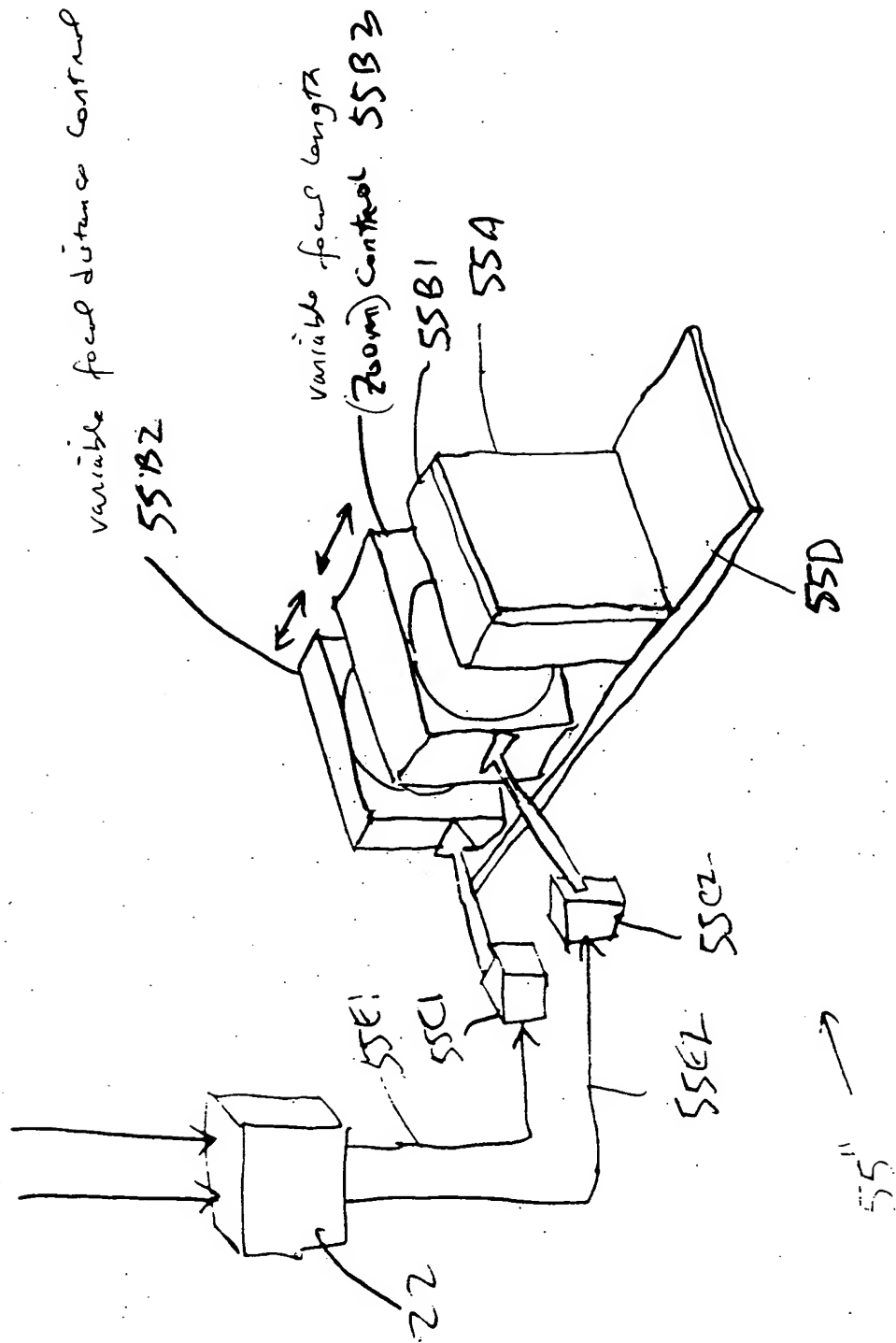


FIG. 6B4

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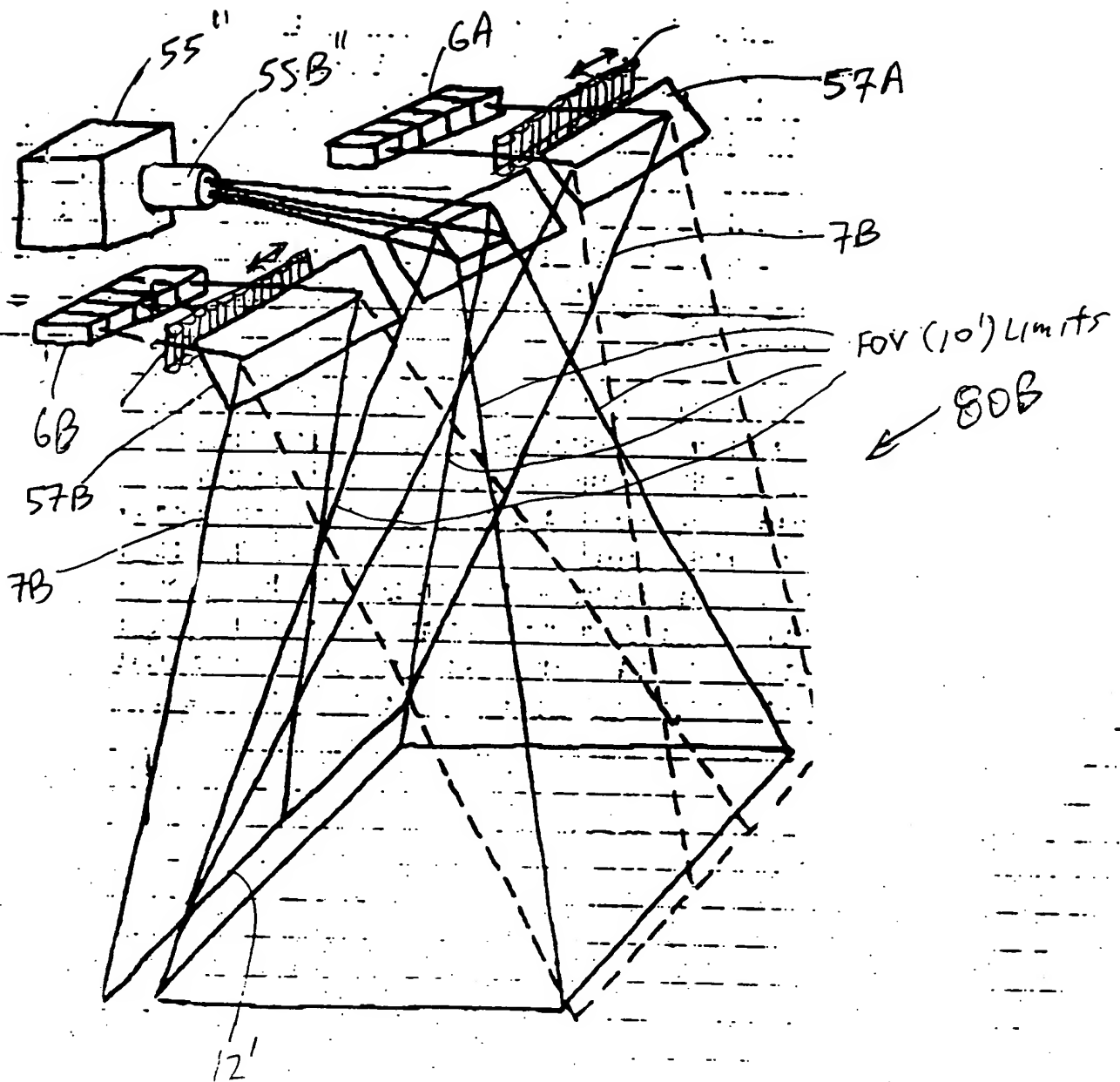
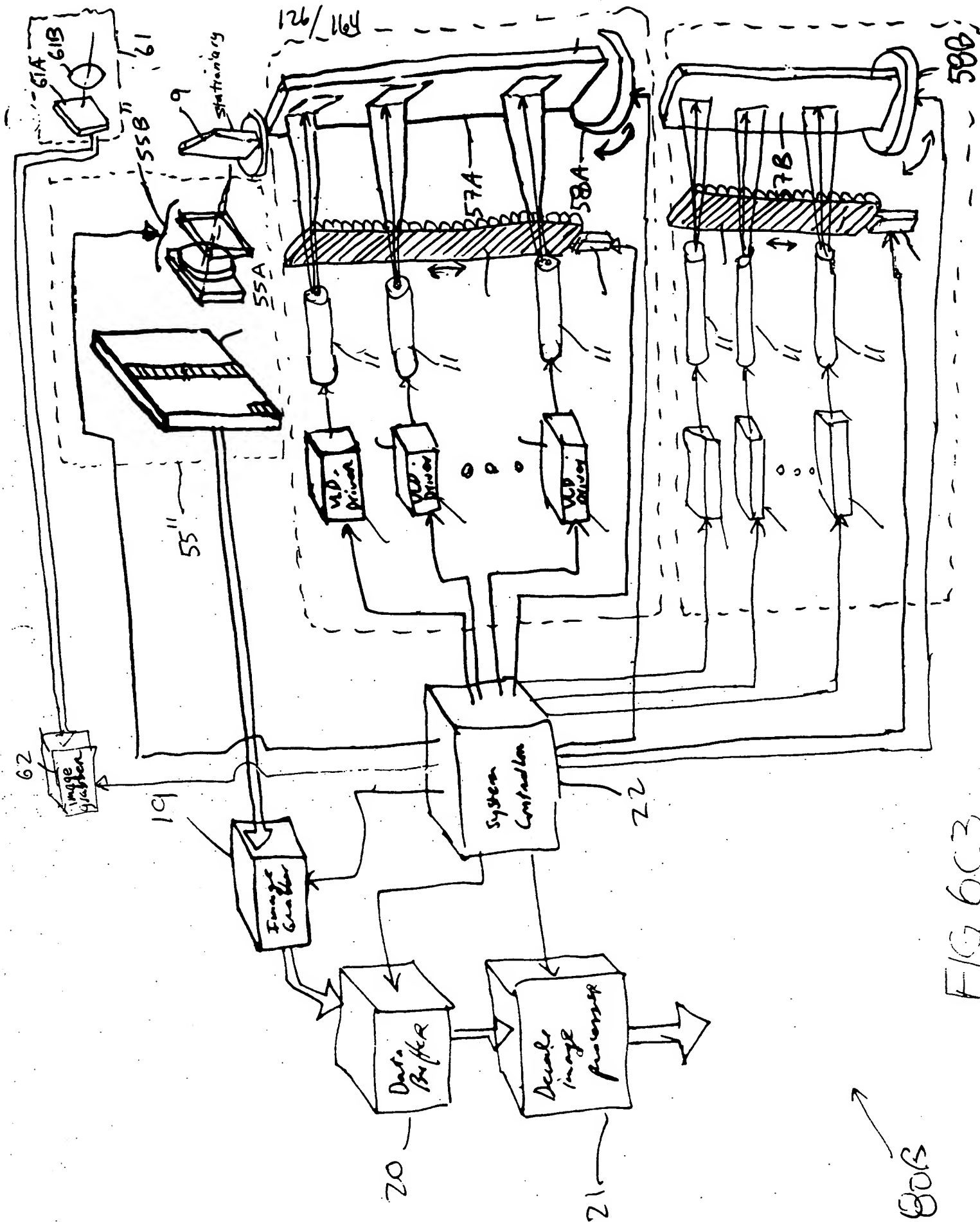


FIG. 6C1

[illegible]

FIG. 6C2



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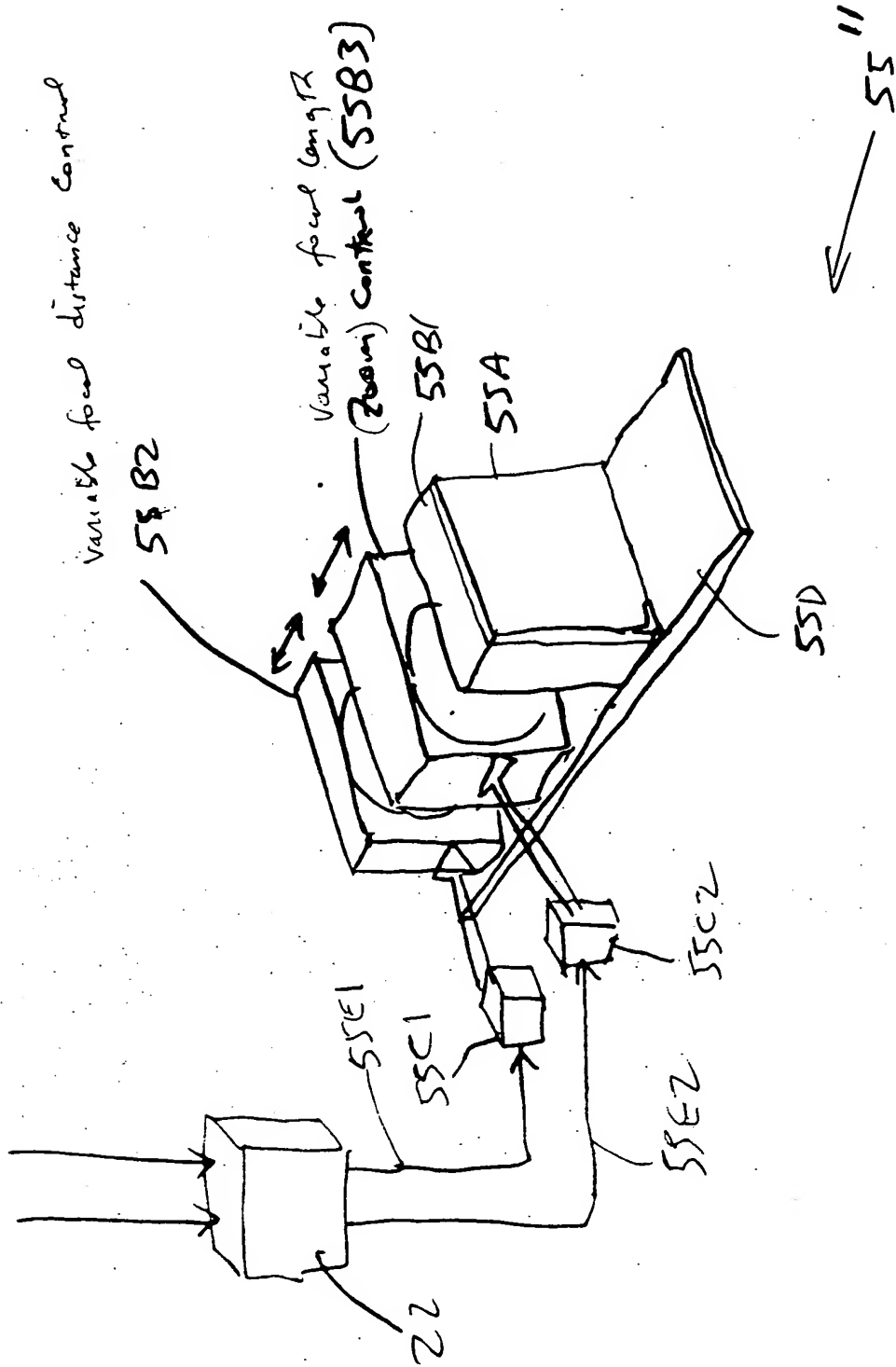


FIG. 6C4

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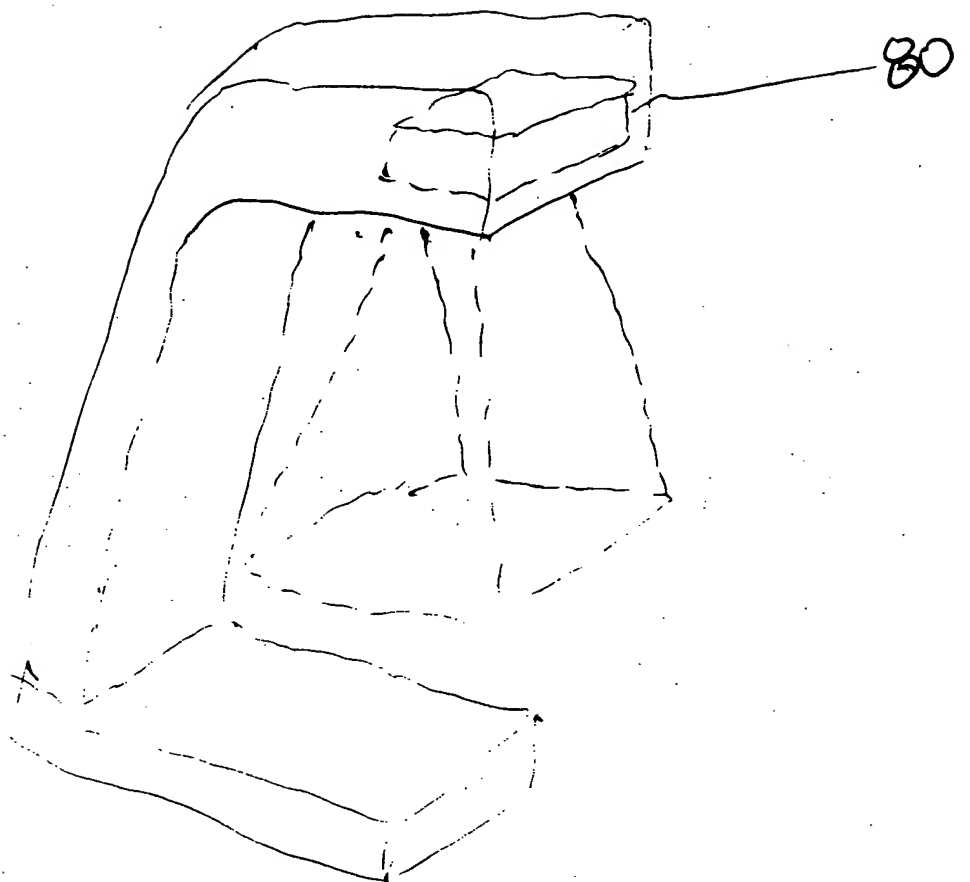


FIG. 6D

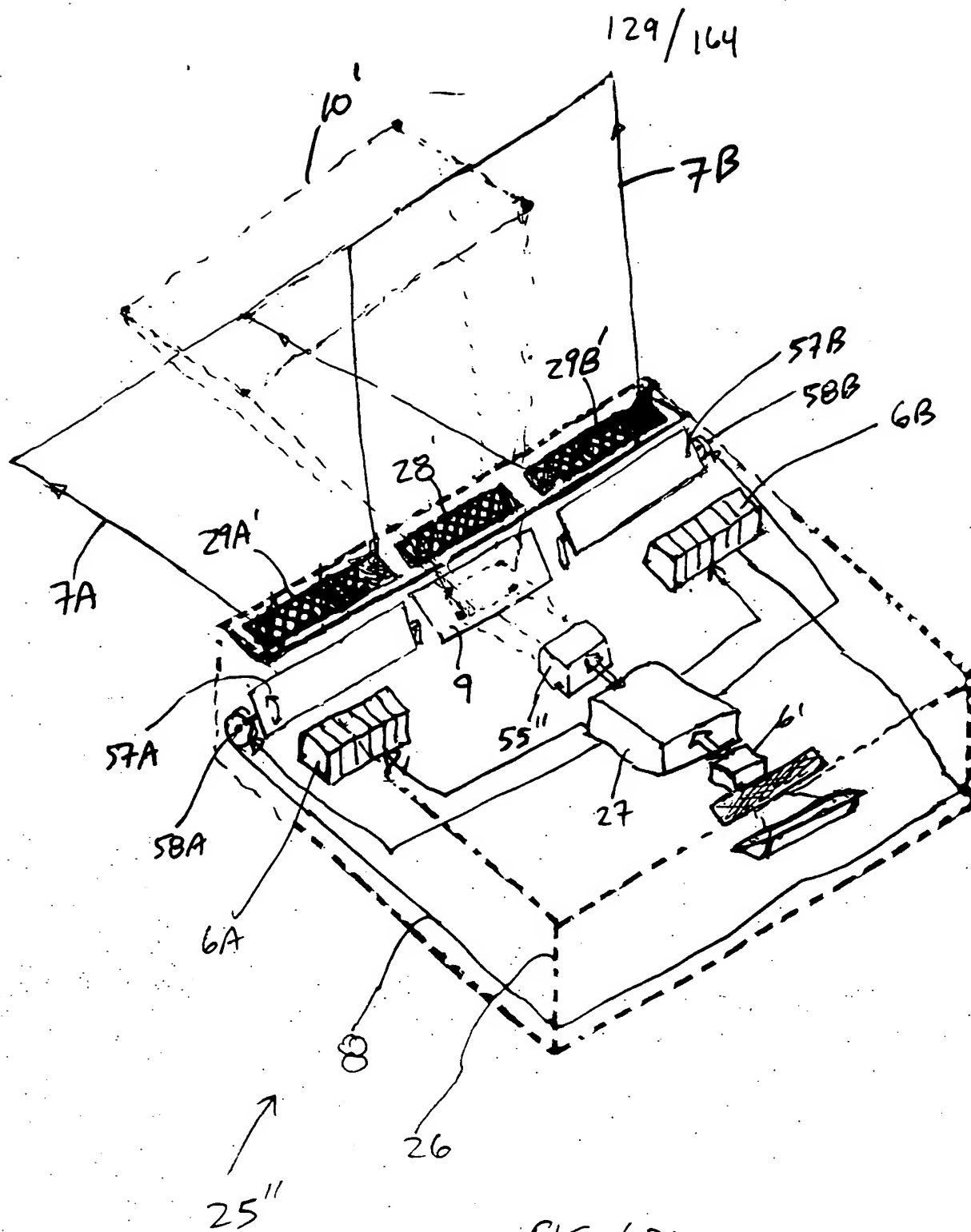


FIG. 6D1

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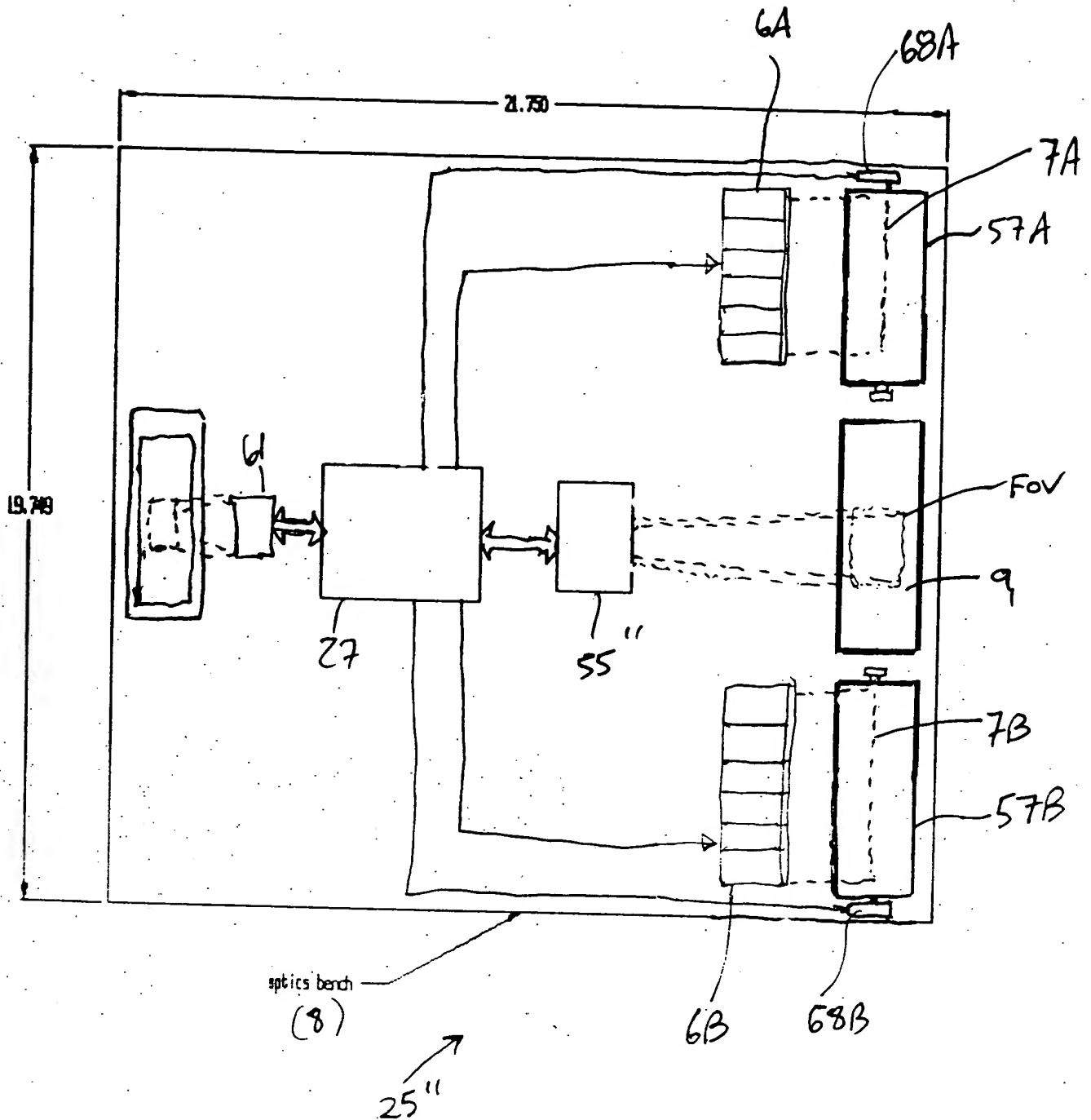


FIG. 6D2

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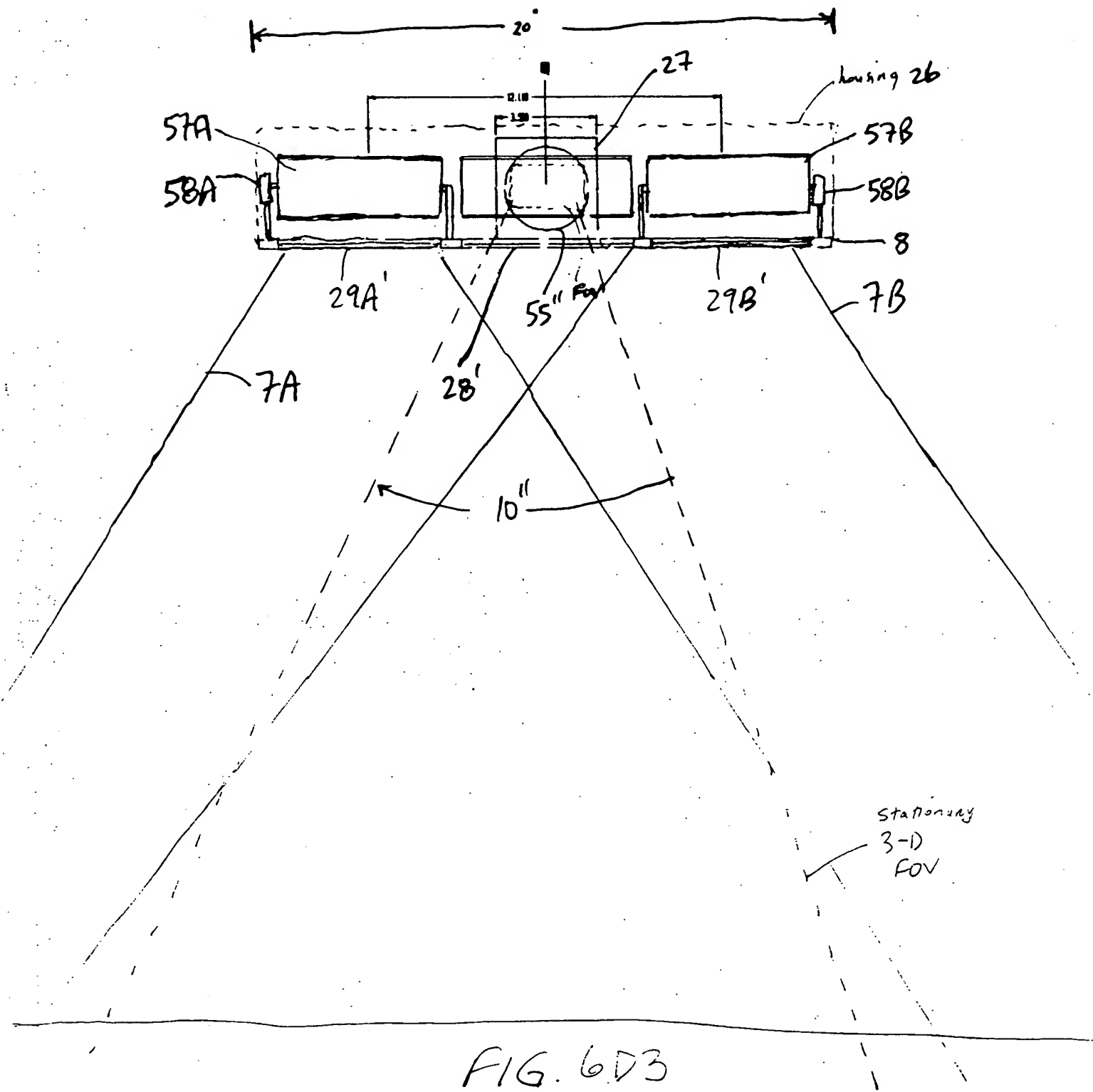
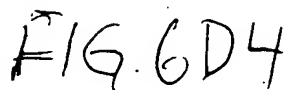


FIG. 6D3

25"



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variable FOV

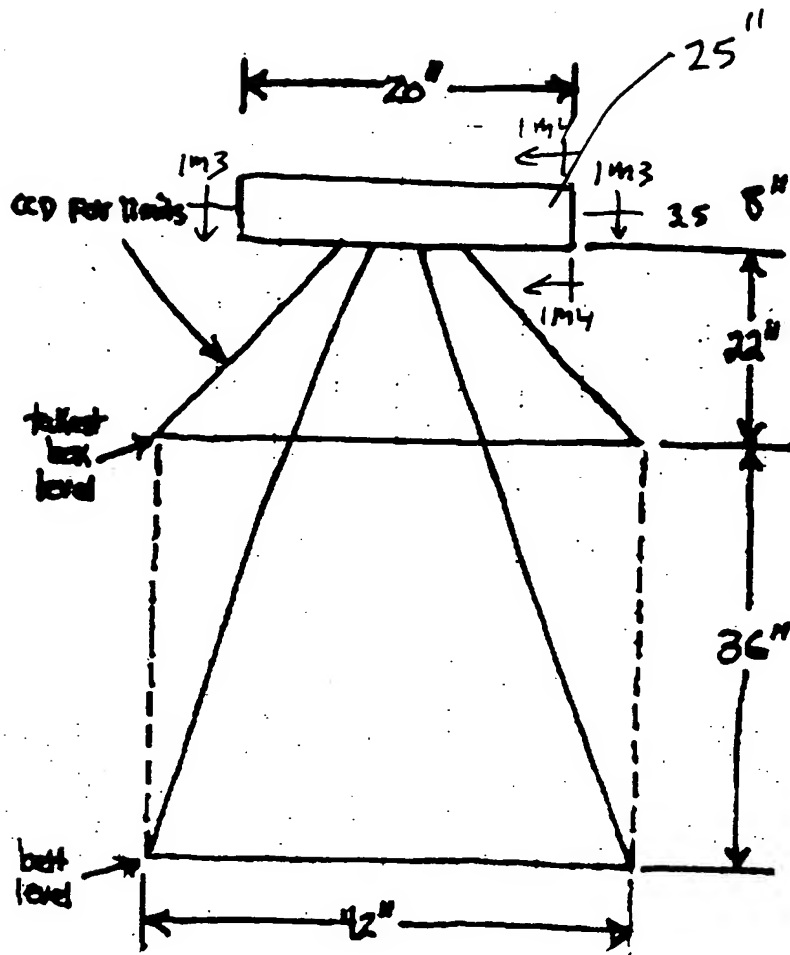
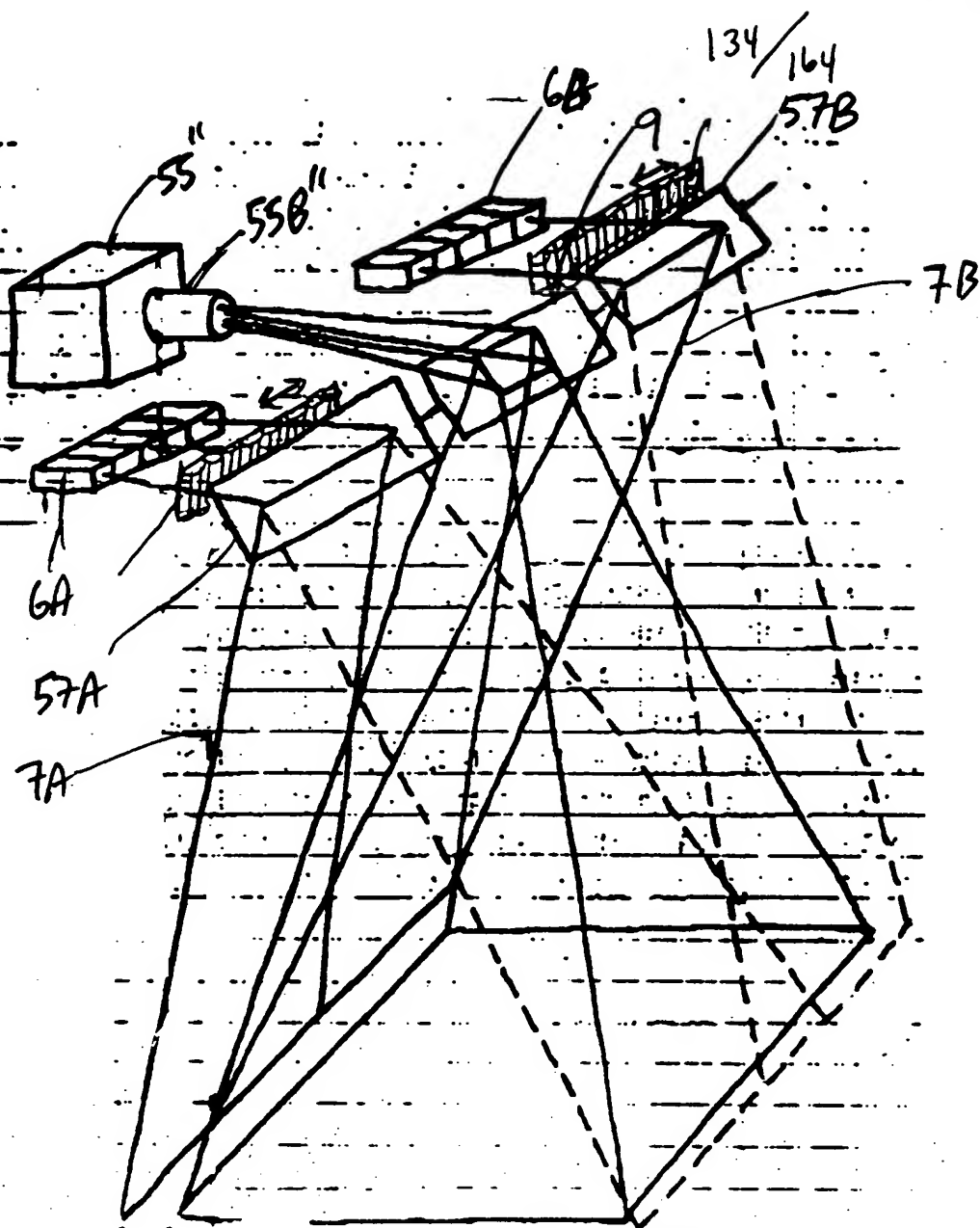


FIG. 6D5



3D FOV is  
movable in 2-dimensions

FIG. 6E1

Length Camera Lens and distance

FIG. 6F2

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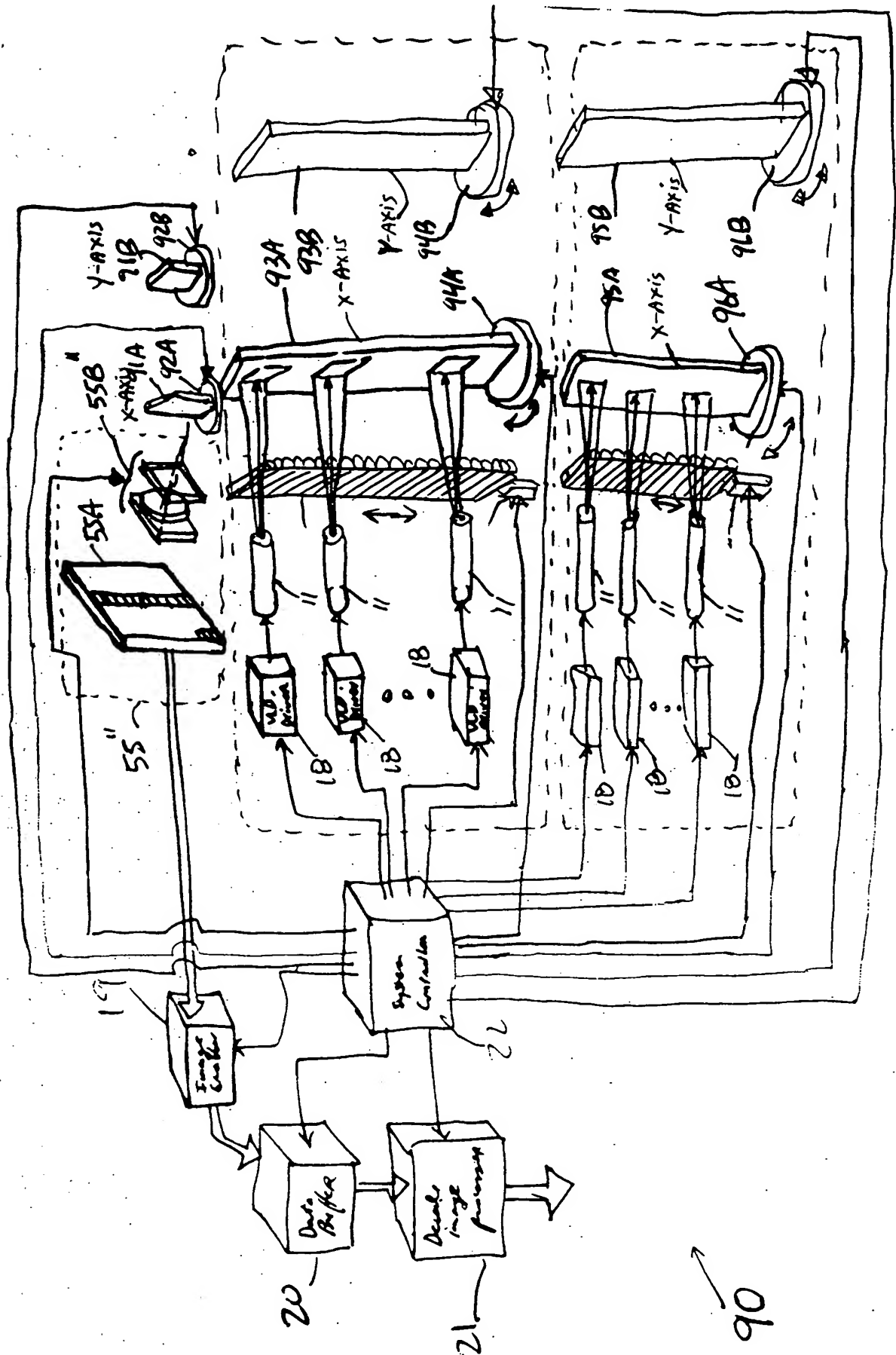
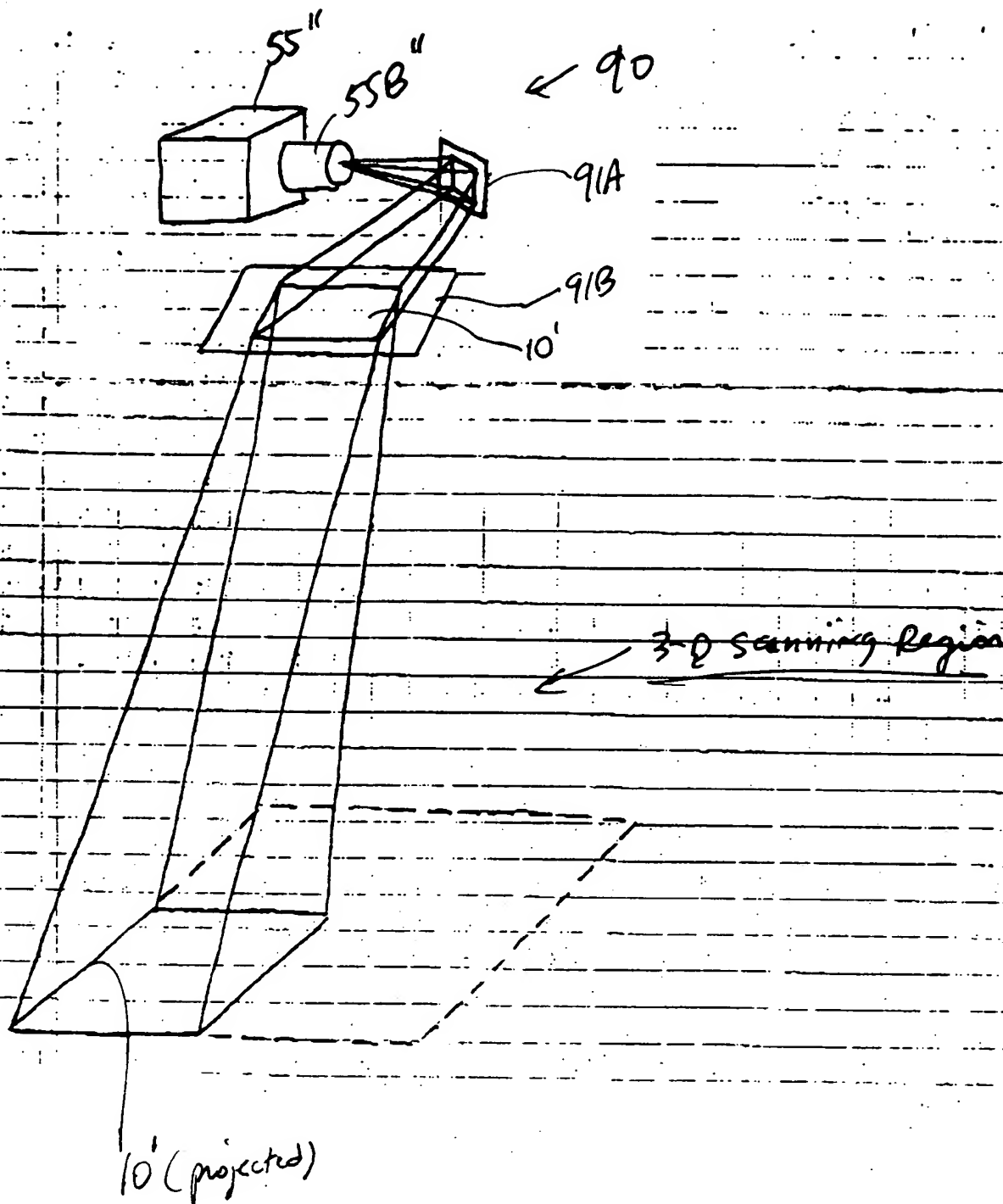


FIG. 6E3

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Holographic PLIDIM  
System employing  
Linear type CCD image  
Detector

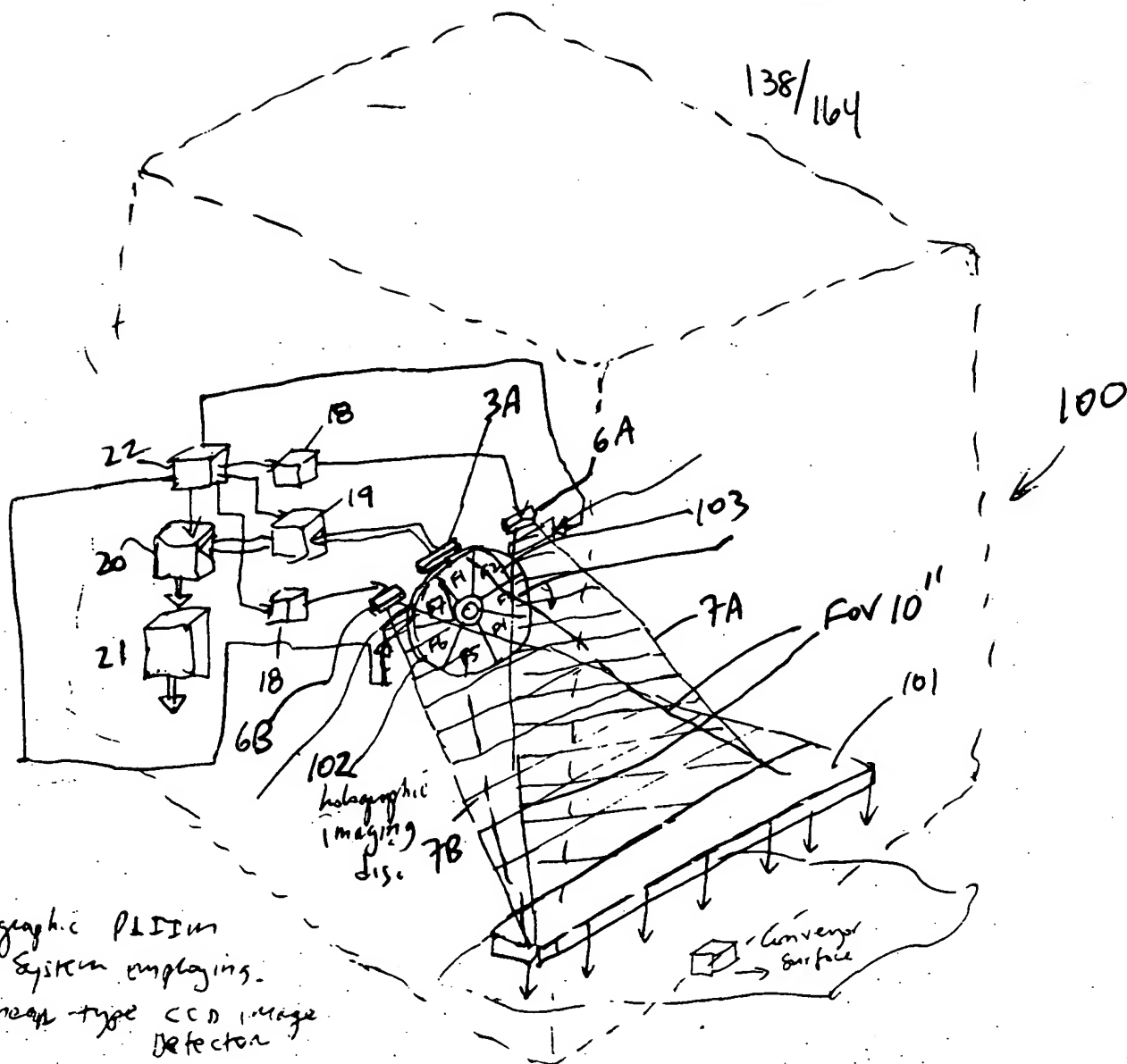


FIG 7A

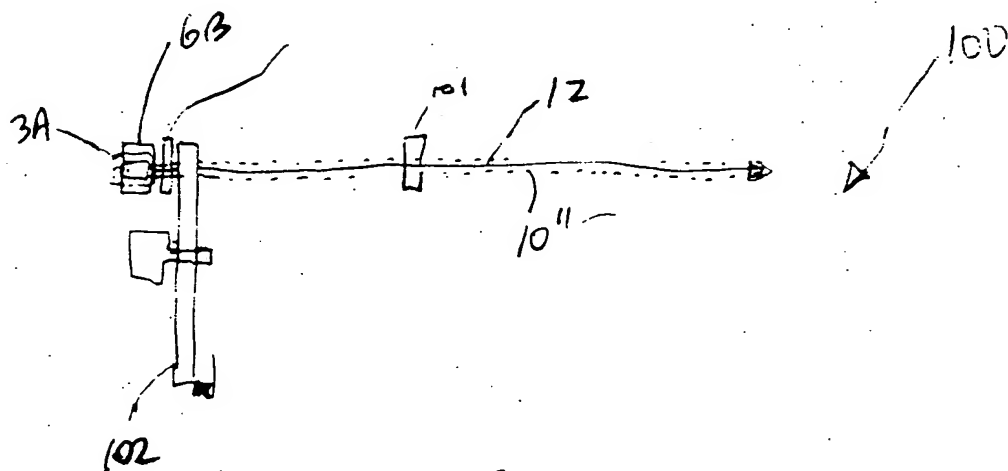


FIG 7B

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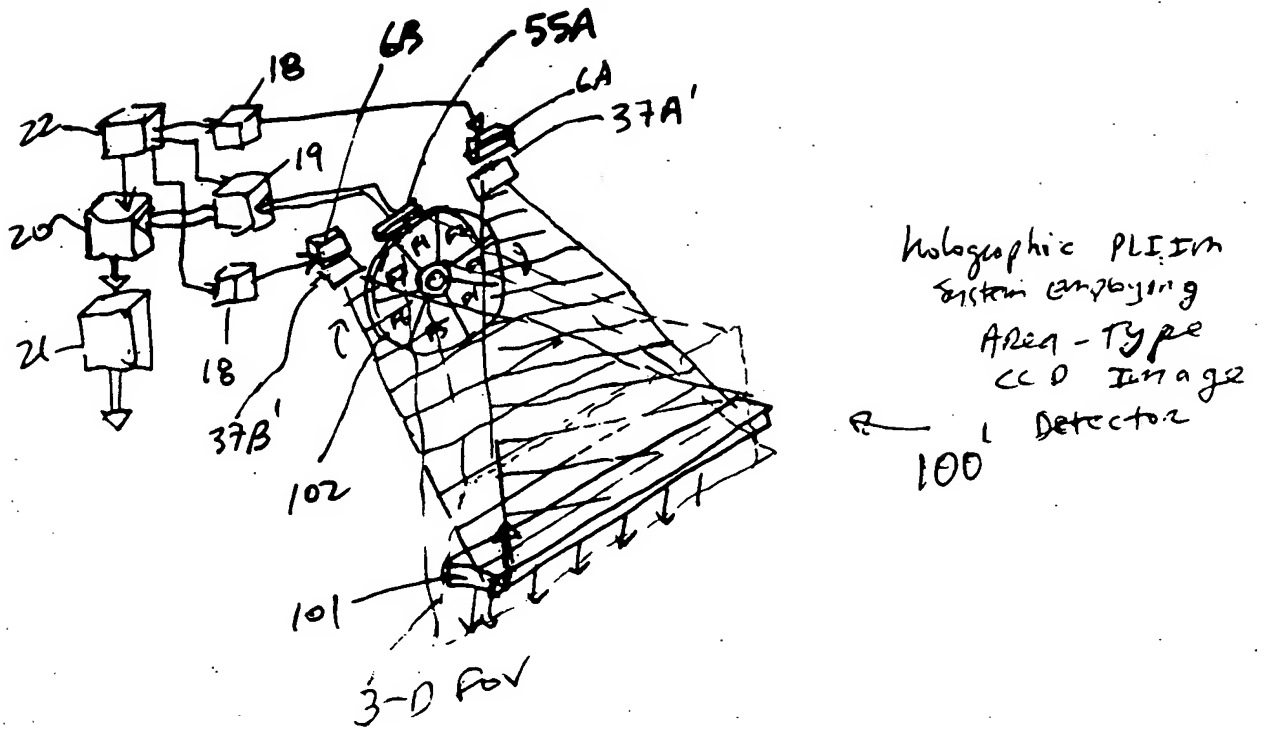


FIG. 8A

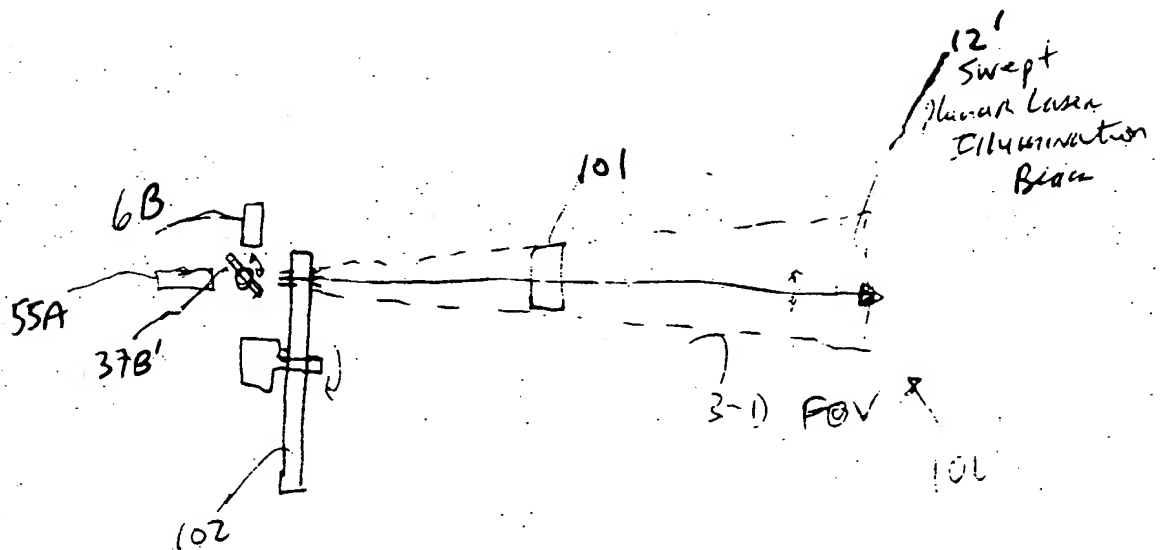


FIG. 8B

### $R_{\text{LOCAL}}$ 1-D CCD SCANNER EMBODIMENT

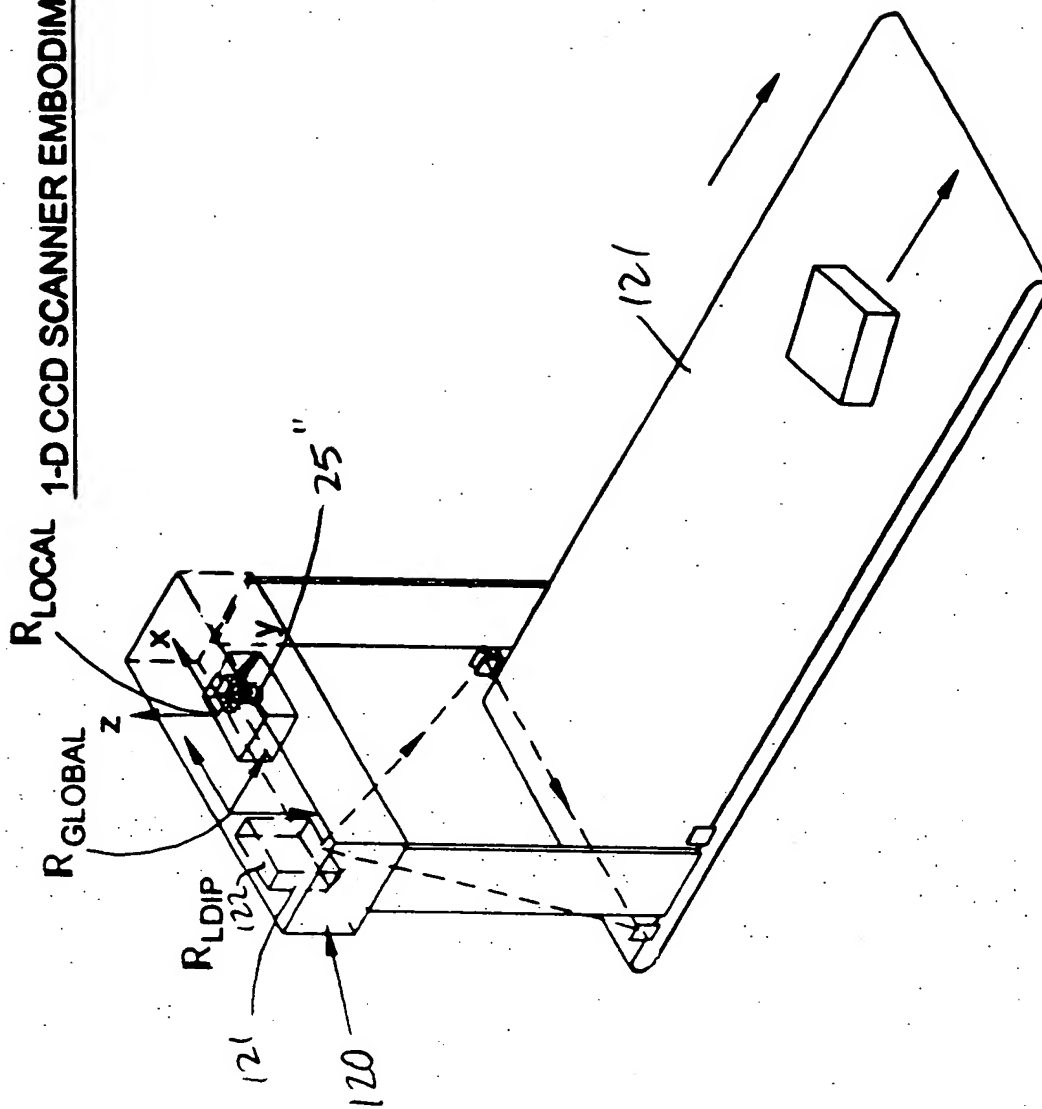


FIG. 9

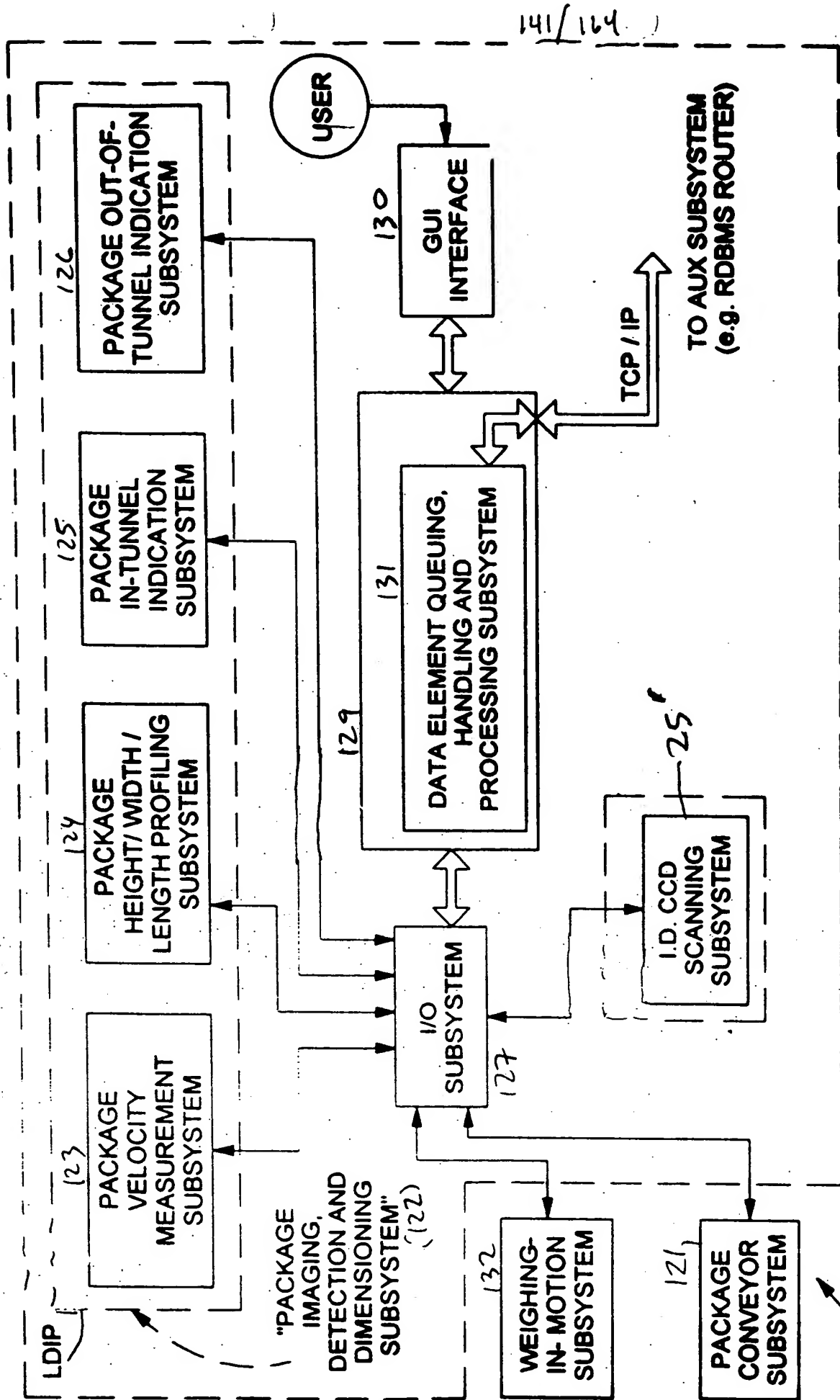


FIG. 10

LOW RESOLUTION 2D CCD CAMERA (61)  
HIGH RESOLUTION 2D CCD CAMERA (55")

LDIP (122)

2.5"

141

140

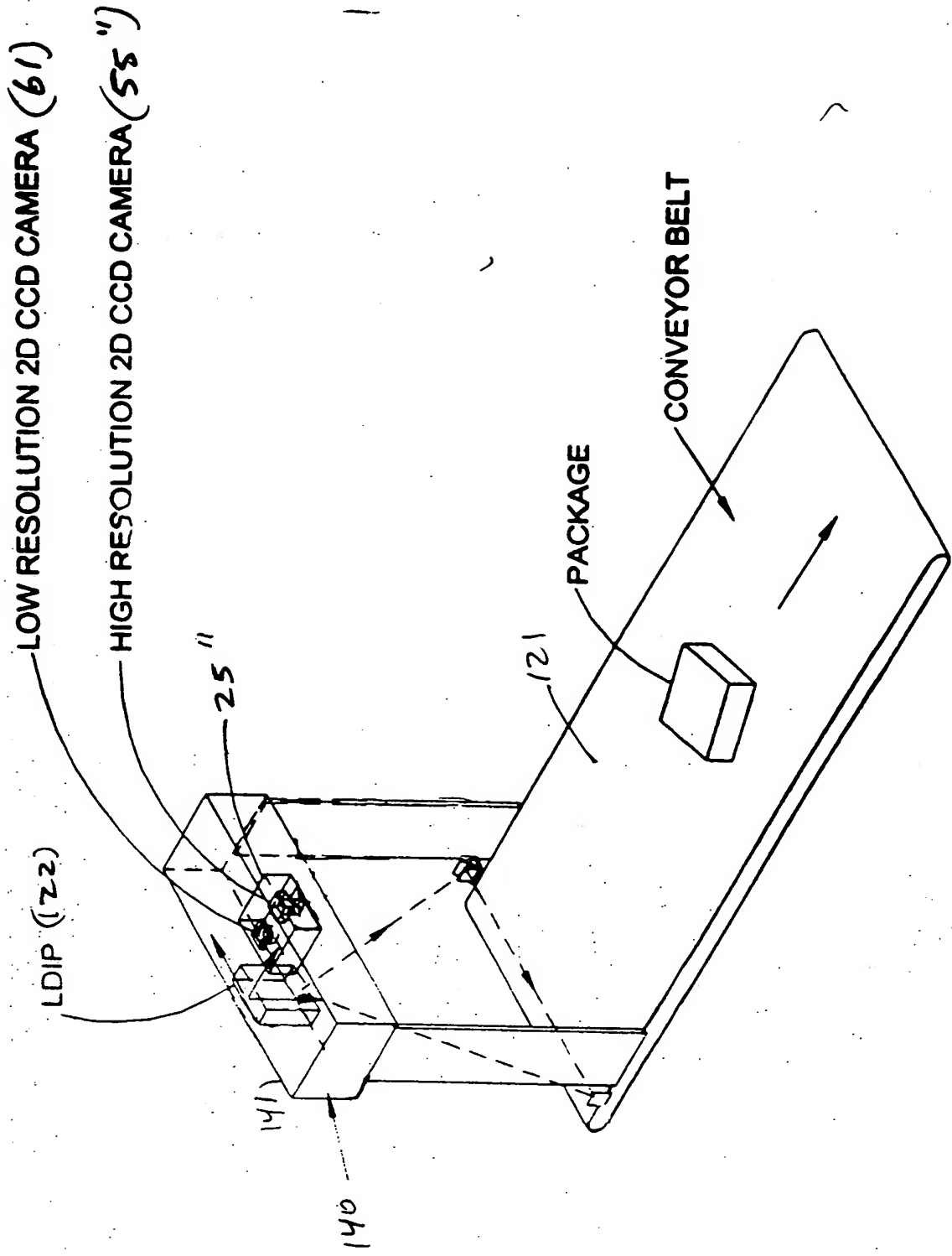
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PACKAGE

CONVEYOR BELT

FIG 11

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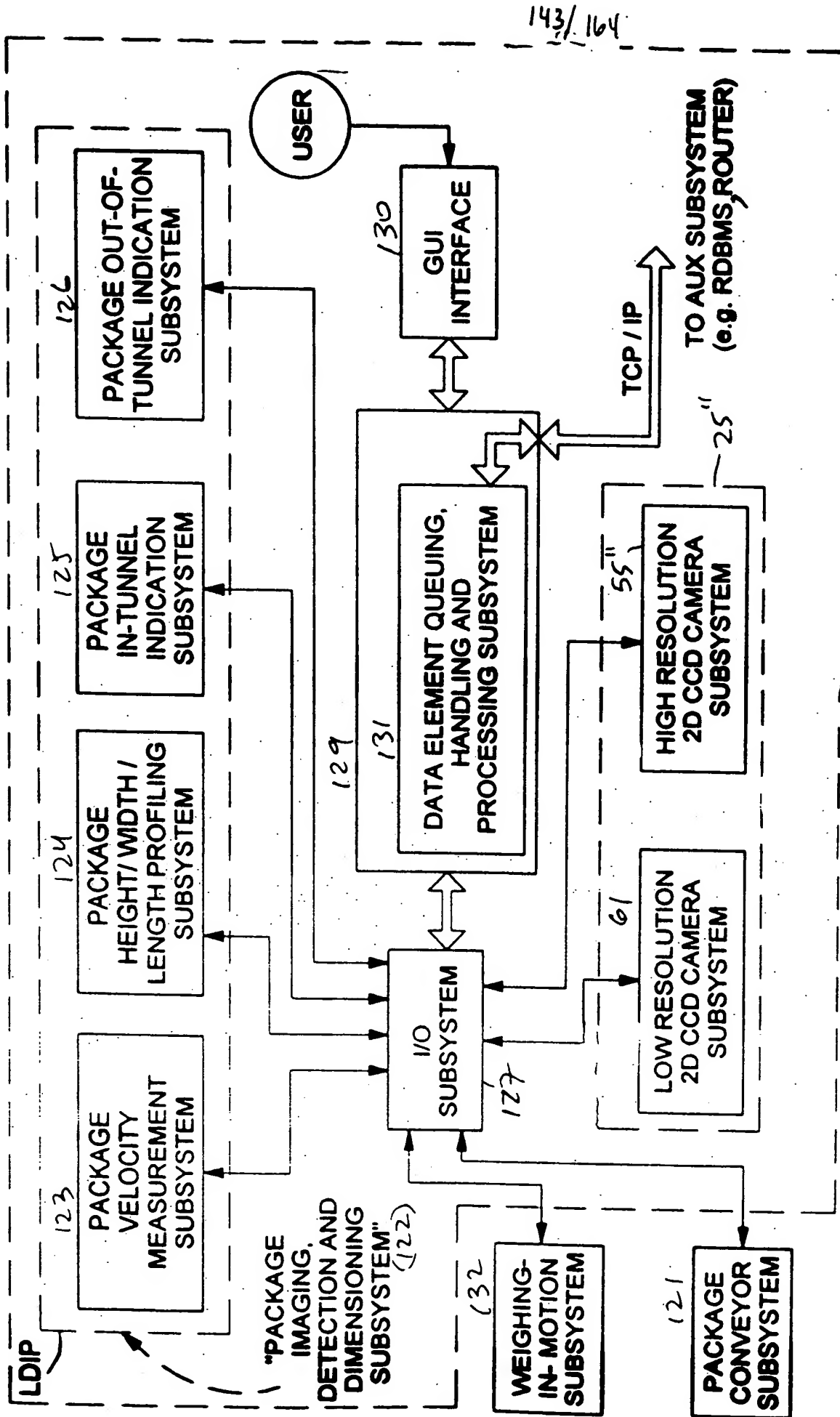


FIG. 12

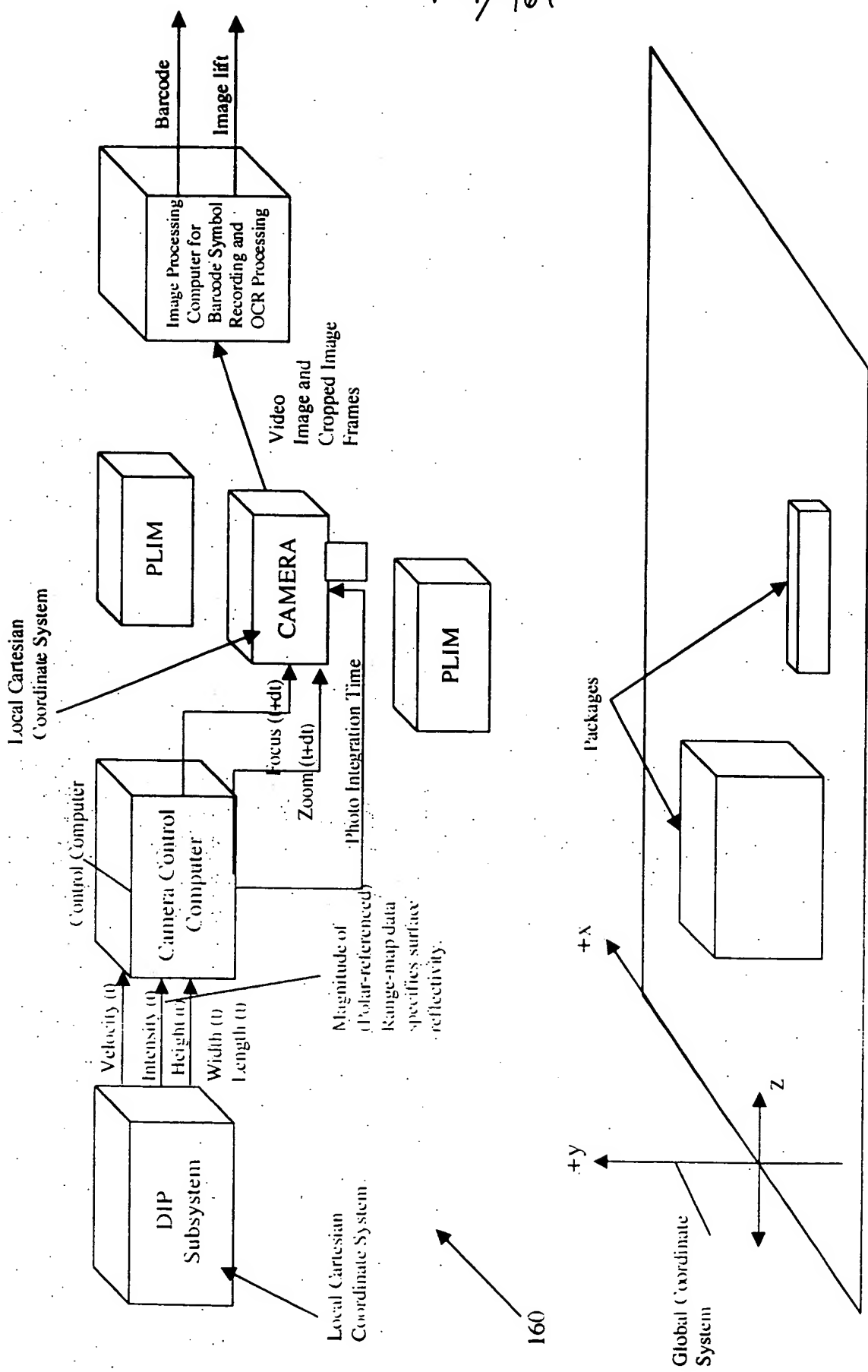


Fig. 13

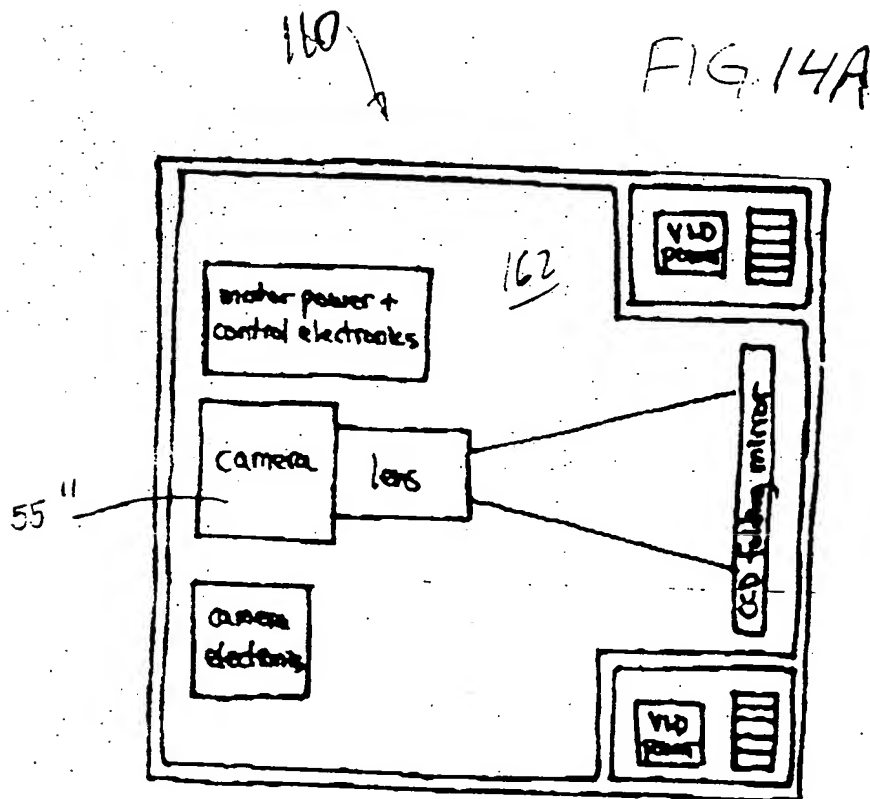
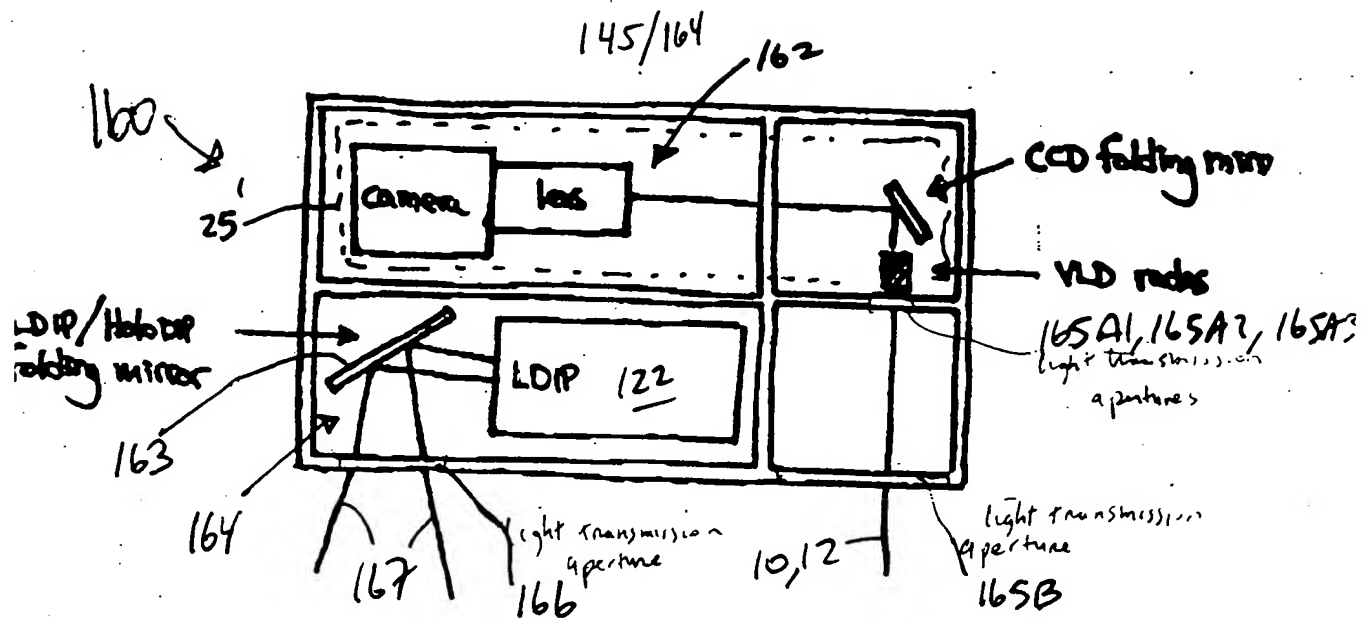


FIG 14B

FIG. 15

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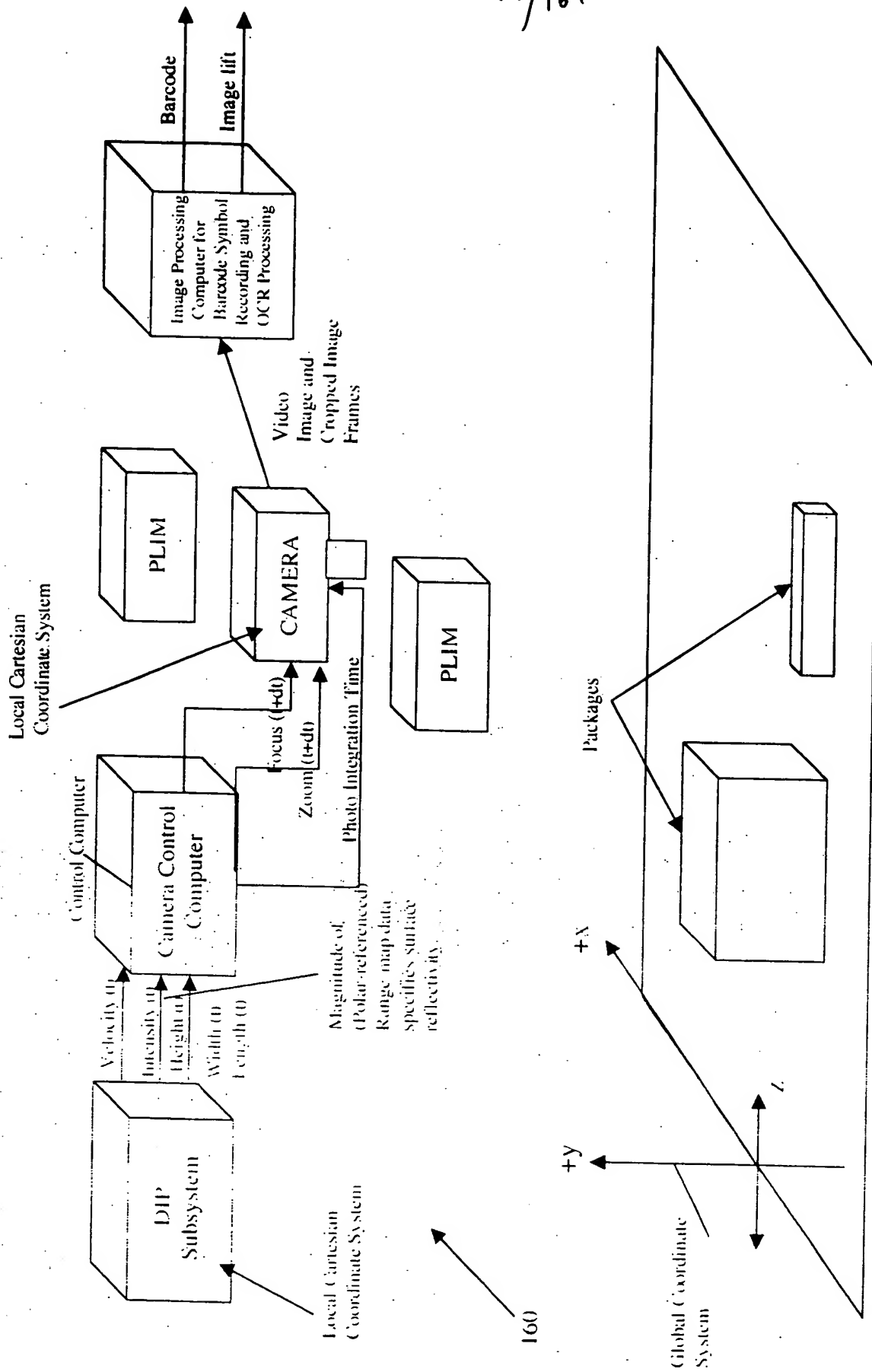


Fig. 16

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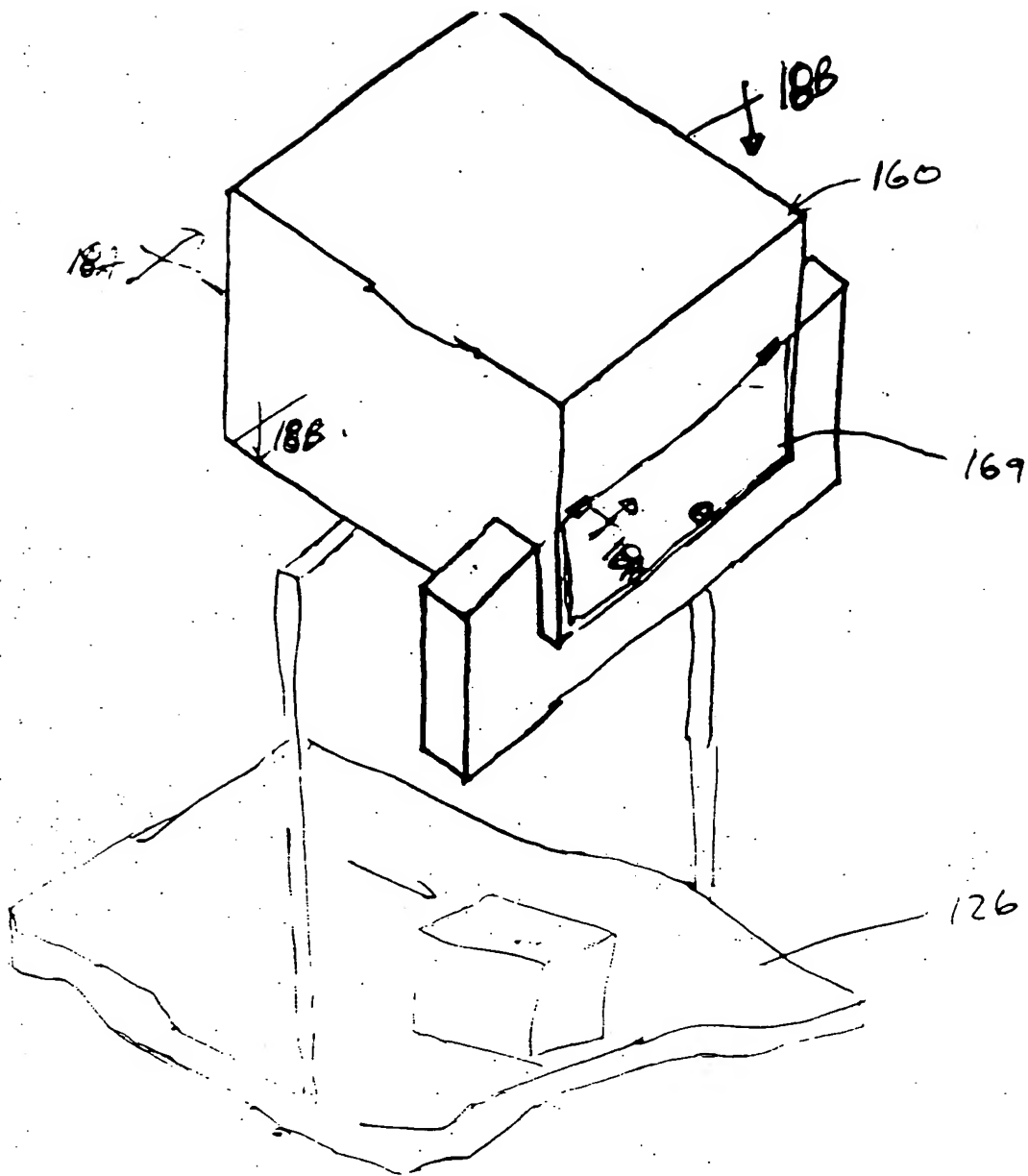


FIG. 17

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upper deck  
top view

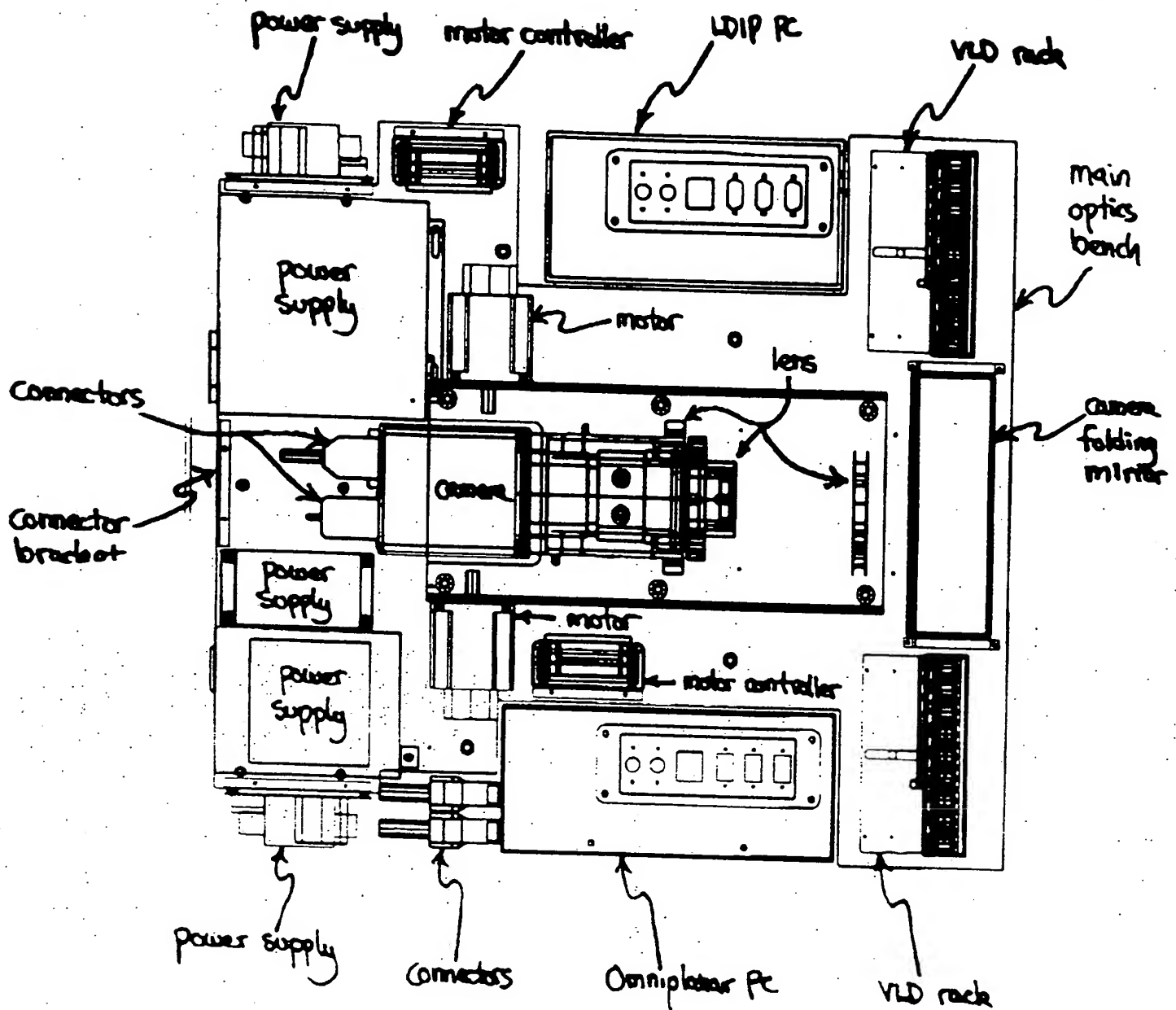


FIG. 18A

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lower deck  
top view

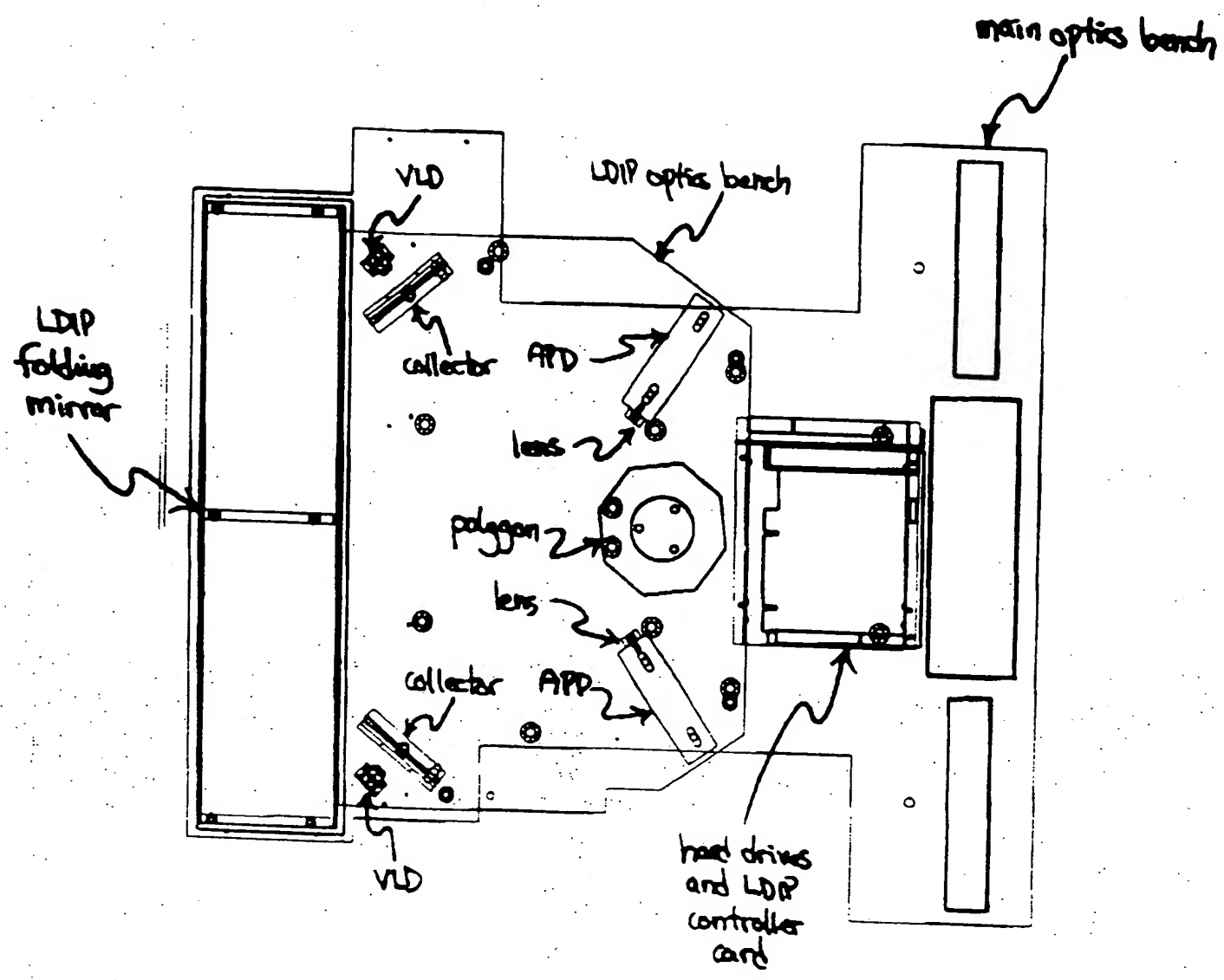
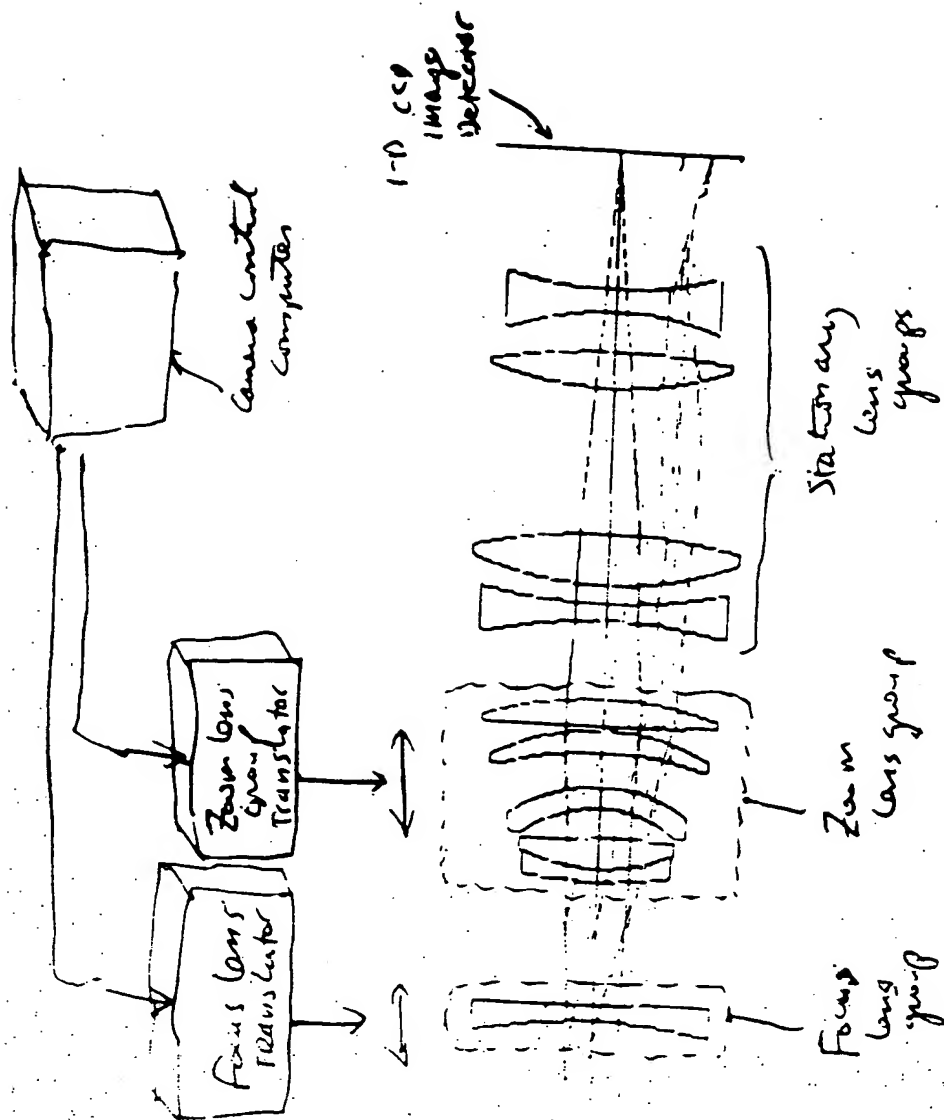


FIG 1EB

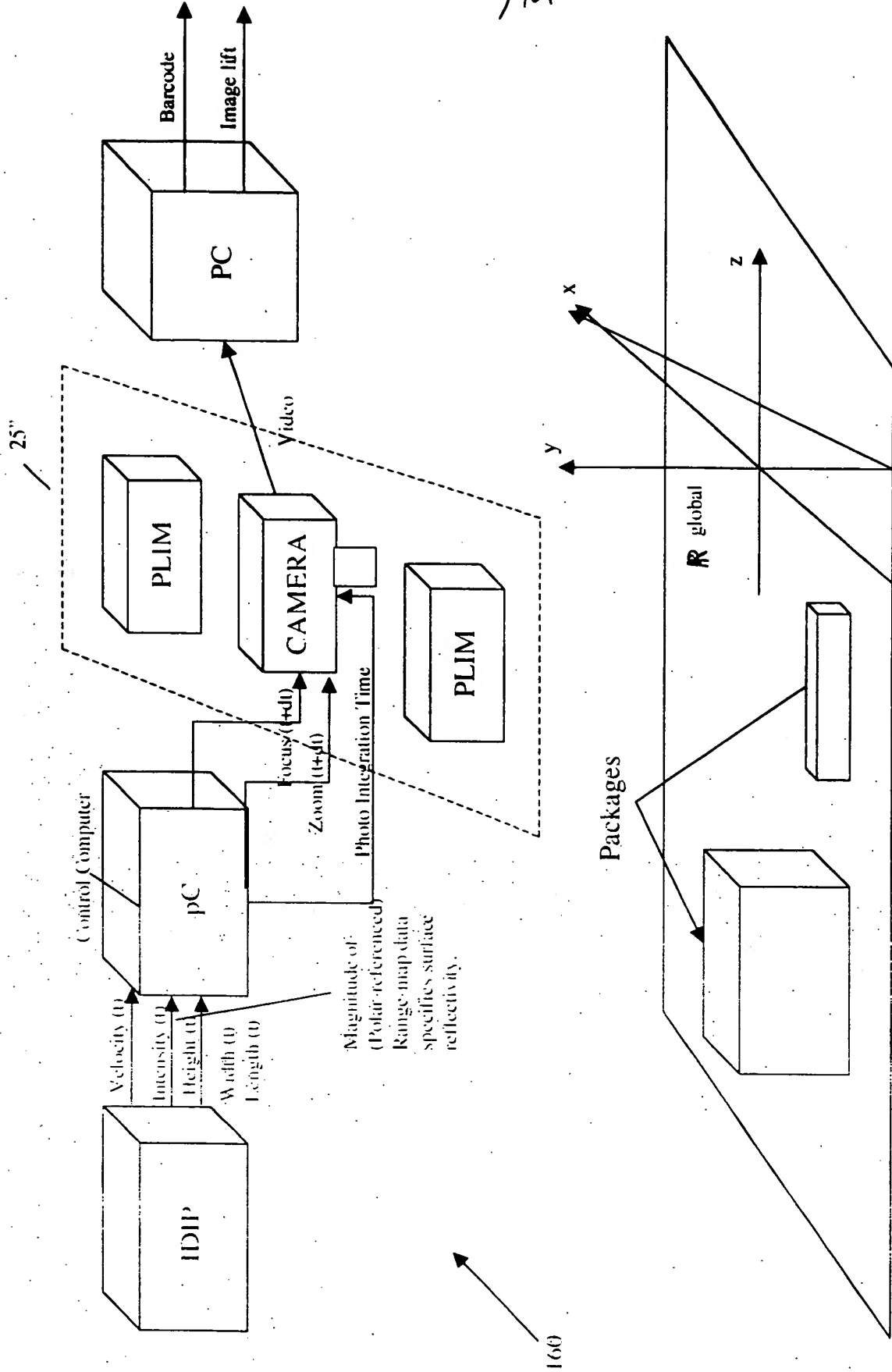
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(main optics)  
(Lens groups)

FIG 18C

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## PLIM-BASED PACKAGE IDENTIFICATION AND DIMENSIONING (PID) SYSTEM

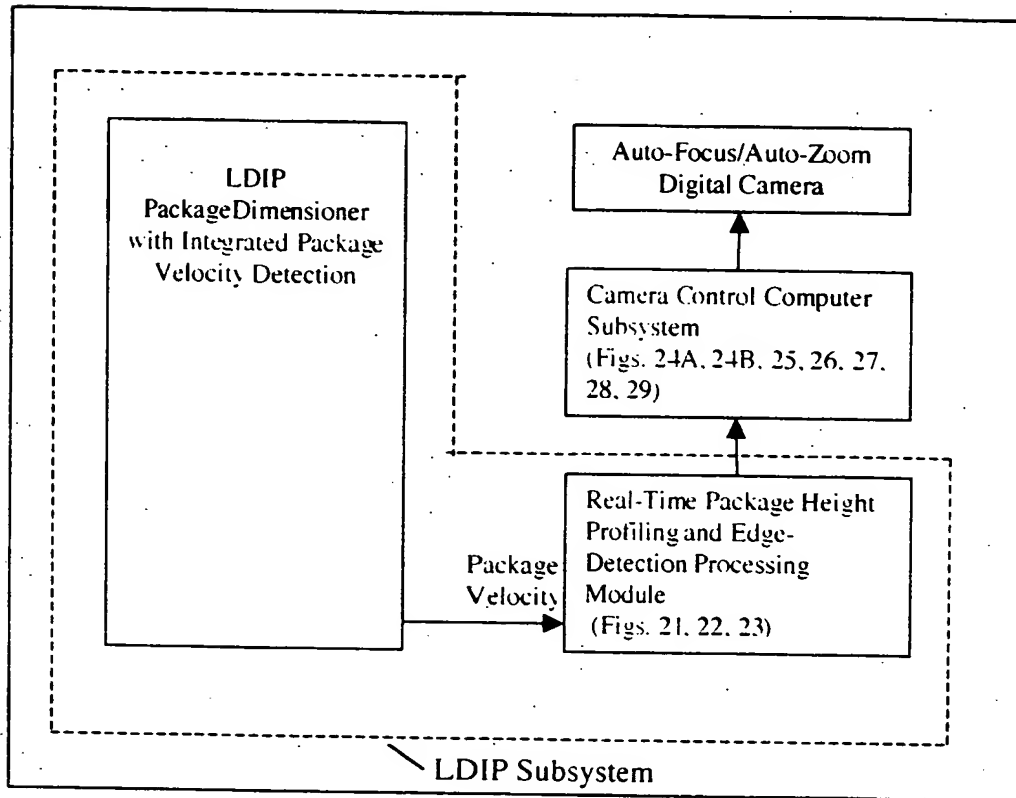
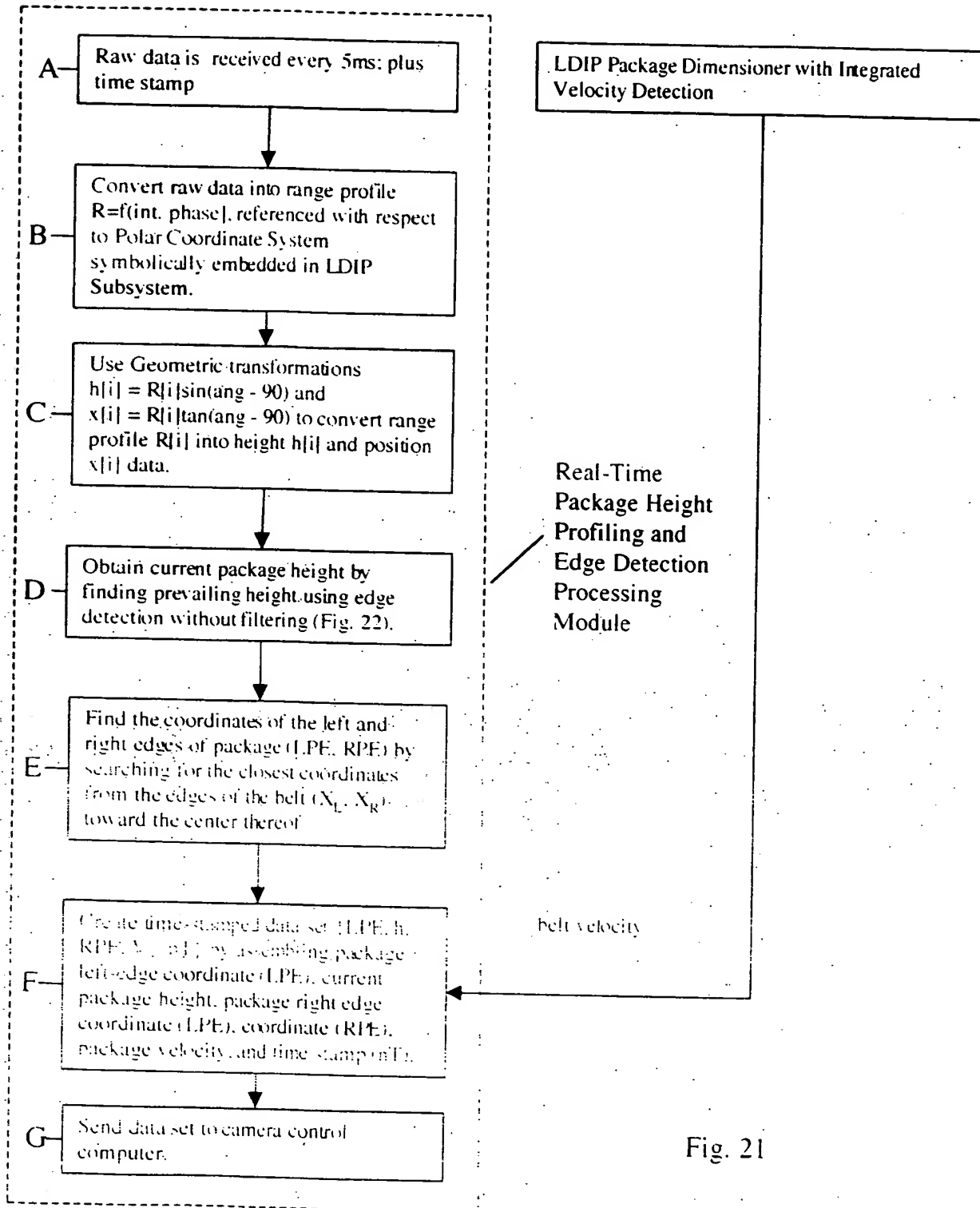


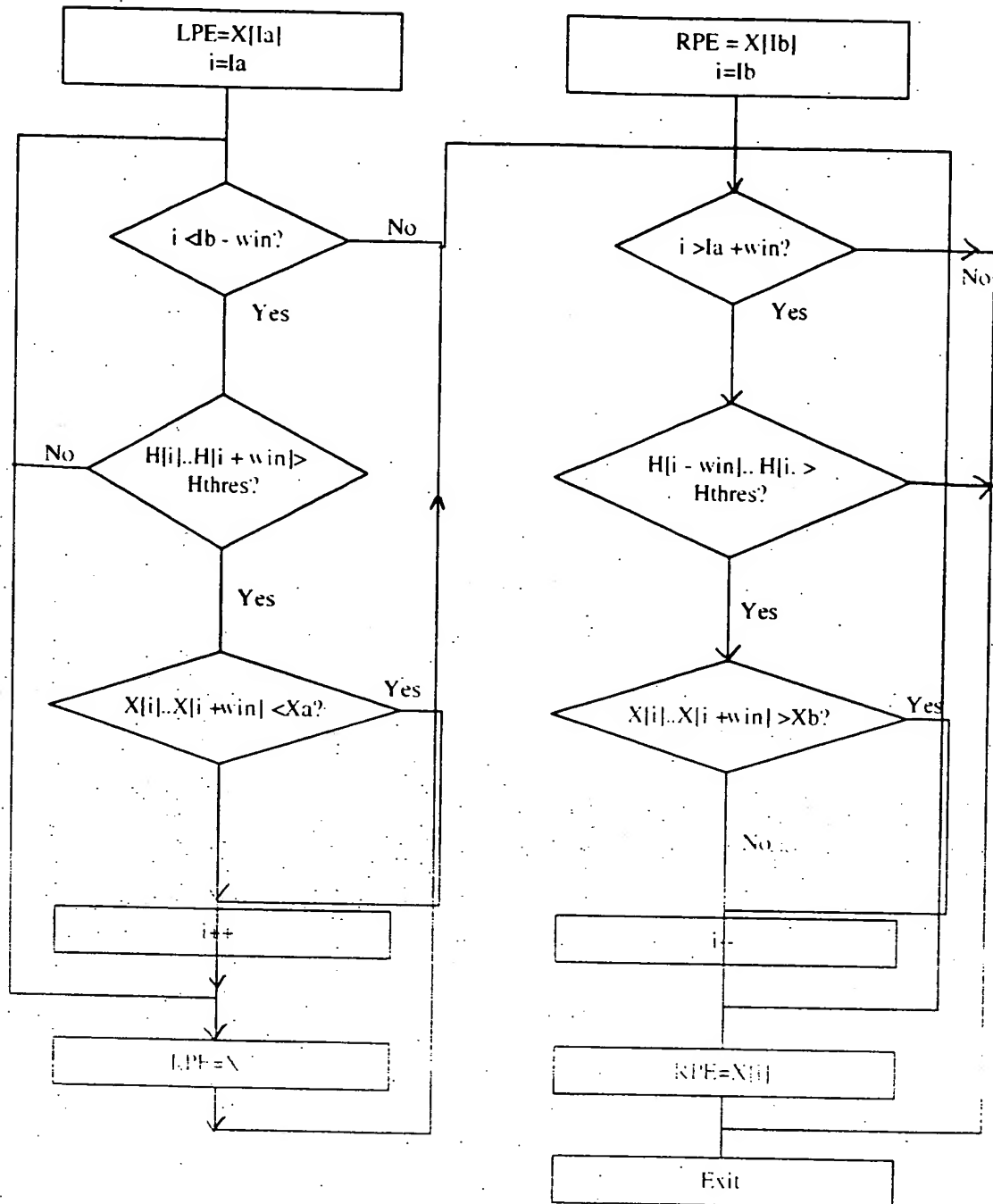
Fig. 20

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# LDIP REAL-TIME PACKAGE HEIGHT PROFILE AND EDGE DETECTION METHOD



# REAL-TIME PACKAGE EDGE DETECTION METHOD



$X_a$  = location of belt left edge;  $X_b$  = location of belt right edge  
 $l_a$  = belt left edge pixel;  $l_b$  = belt right edge pixel  
 $LPE$  = Left package edge;  $RPE$  = Right package edge  
 $H[i]$  = Pixel height array;  $X[i]$  = Pixel location array  
 $win$  = package detection window

Fig. 22

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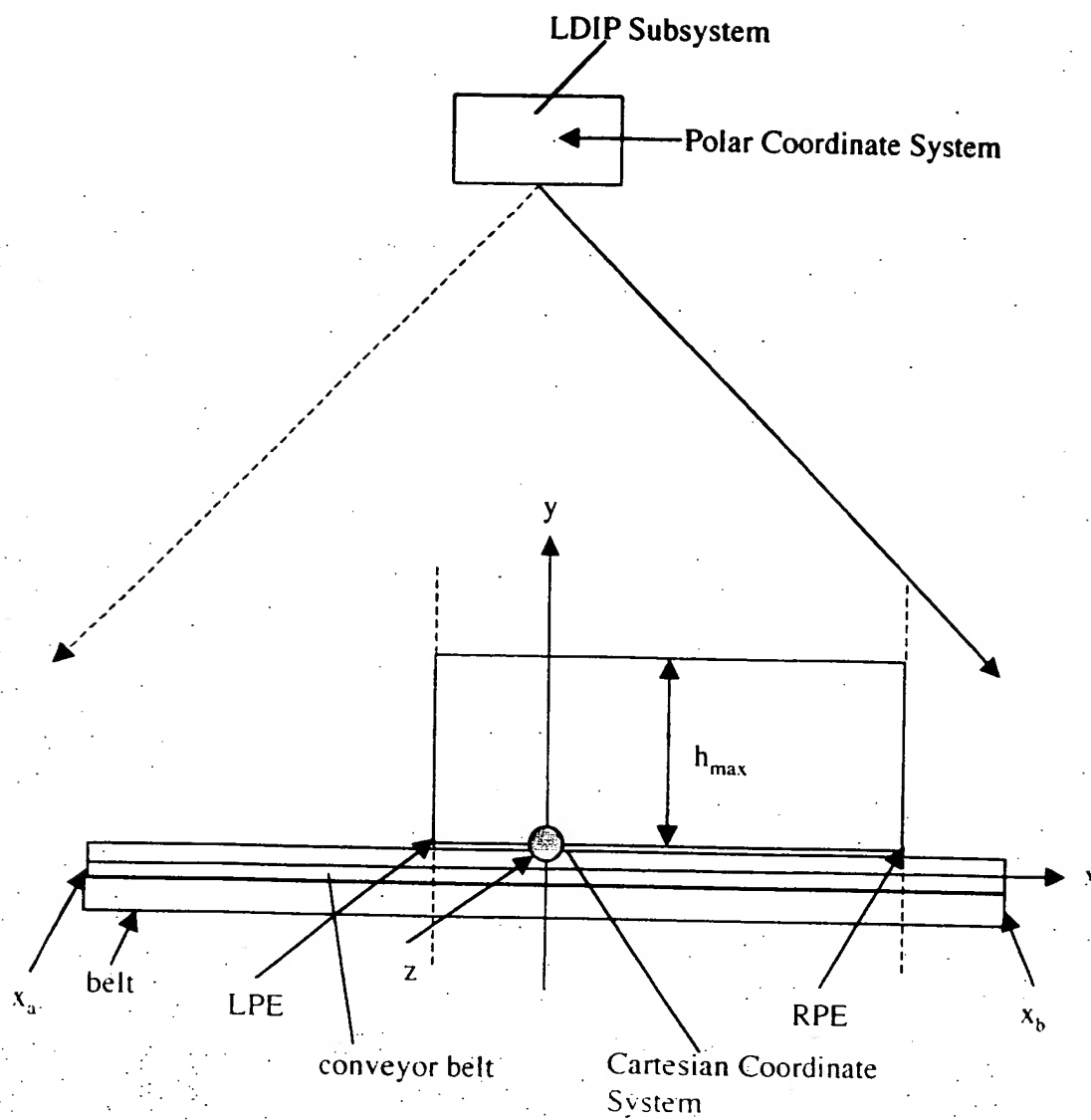


Fig. 23

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# CAMERA CONTROL PROCESS CARRIED OUT WITHIN THE CAMERA CONTROL SUBSYSTEM

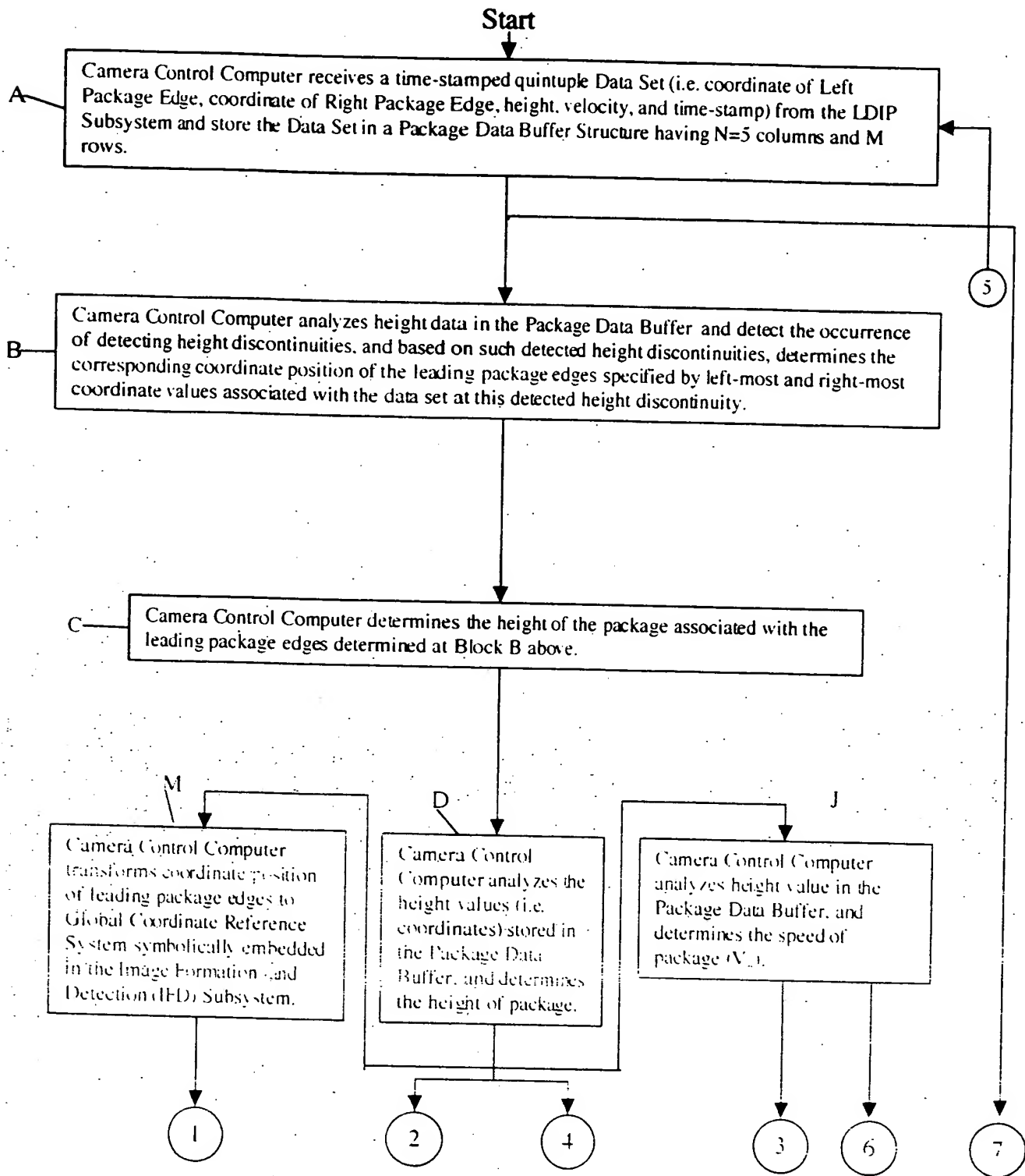


Fig. 24A

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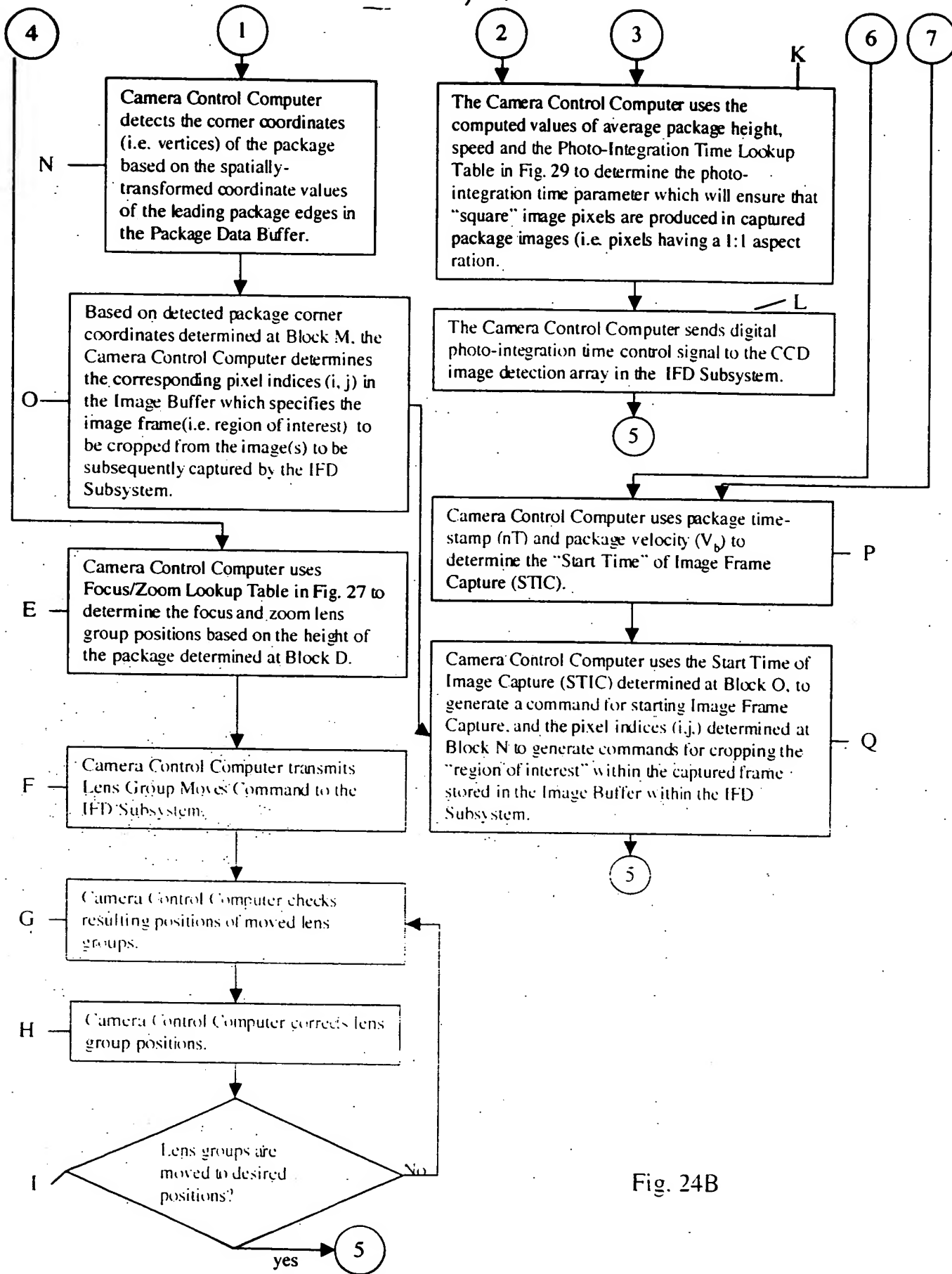


Fig. 24B

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Left Package Edge (LDE)	Package Height (h)	Right Package Edge (RPE)	Package Velocity	Time-stamp (nT)	
					Row 1
					Row 2
					Row 3
					Row 4
					Row 5
					Row M

Package Data Buffer (FIFO)

Fig. 25

																				Columns →
																				Rows ↓

Camera Pixel Data Buffer  
pixel indices (i,j,)

Fig. 26

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Position and Focus Lens Group Position  
Looking Table

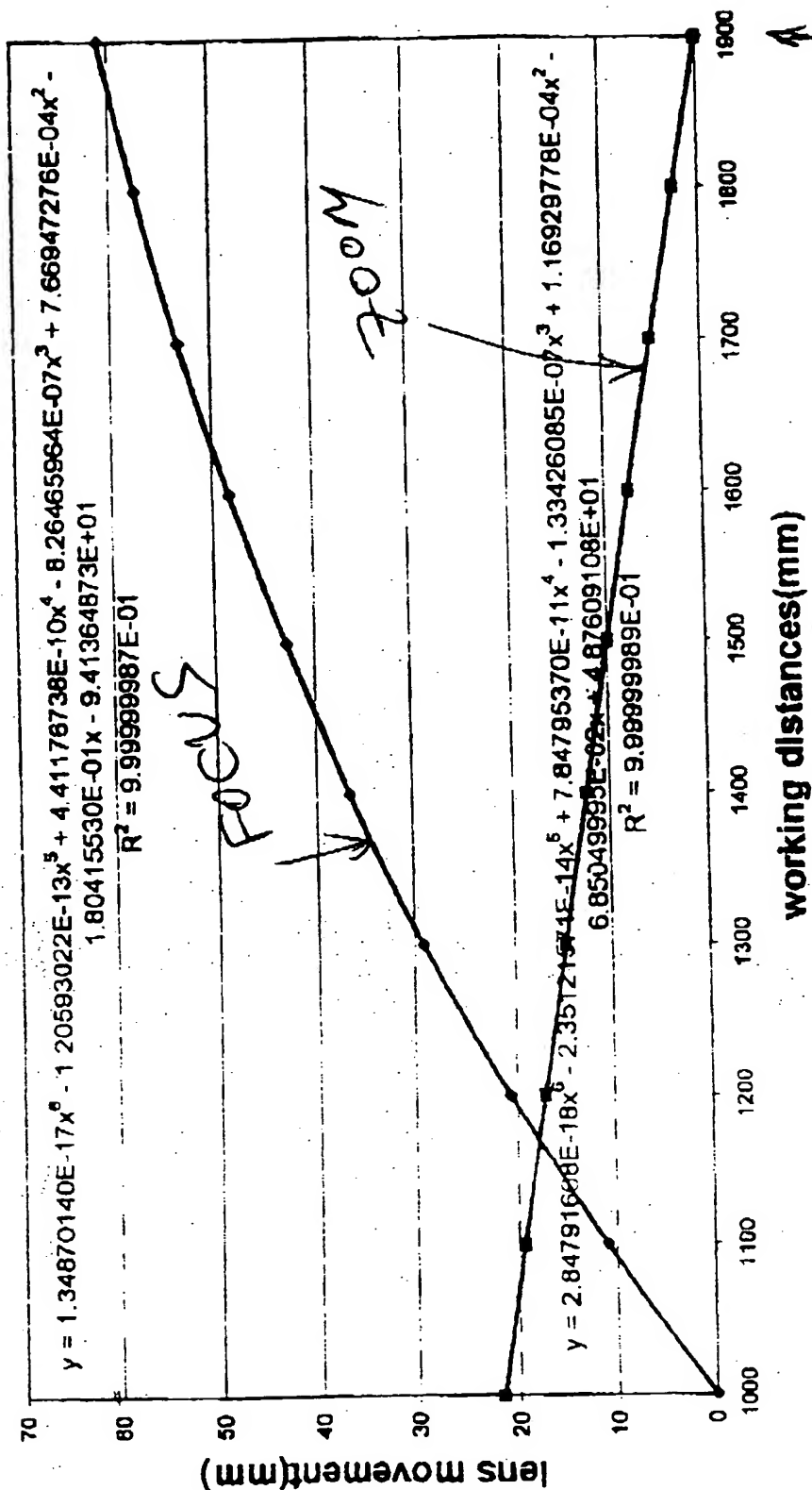
Distance from Camera H (mm)	Zoom group distance (mm) Y (Zoom)	Focus group distance (mm) Y (Focus)
1000	21.57489228	2.47E-05
1100	19.38089696	10.99009783
1200	17.10673434	20.65783177
1300	14.77137314	29.10917002
1400	12.39153565	36.47312595
1500	9.979114358	42.87845436
1600	7.540639114	48.44003358
1700	5.078794775	53.25495831
1800	2.595989366	57.40834303
1900	0.099972739	60.98883615

(use  
interpolation  
technique  
for working  
distances  
between listed  
points in  
table)

FIG. 27

camera has a  
fixed aperture F5.6

# Focus and Zoom lens movement vs. working distances



Legend:  $\diamond$  zoom 1  $\square$  zoom 2 — Poly. (zoom 1) — Poly. (zoom 2)

36 inches above conveyor belt

Package height above conveyor

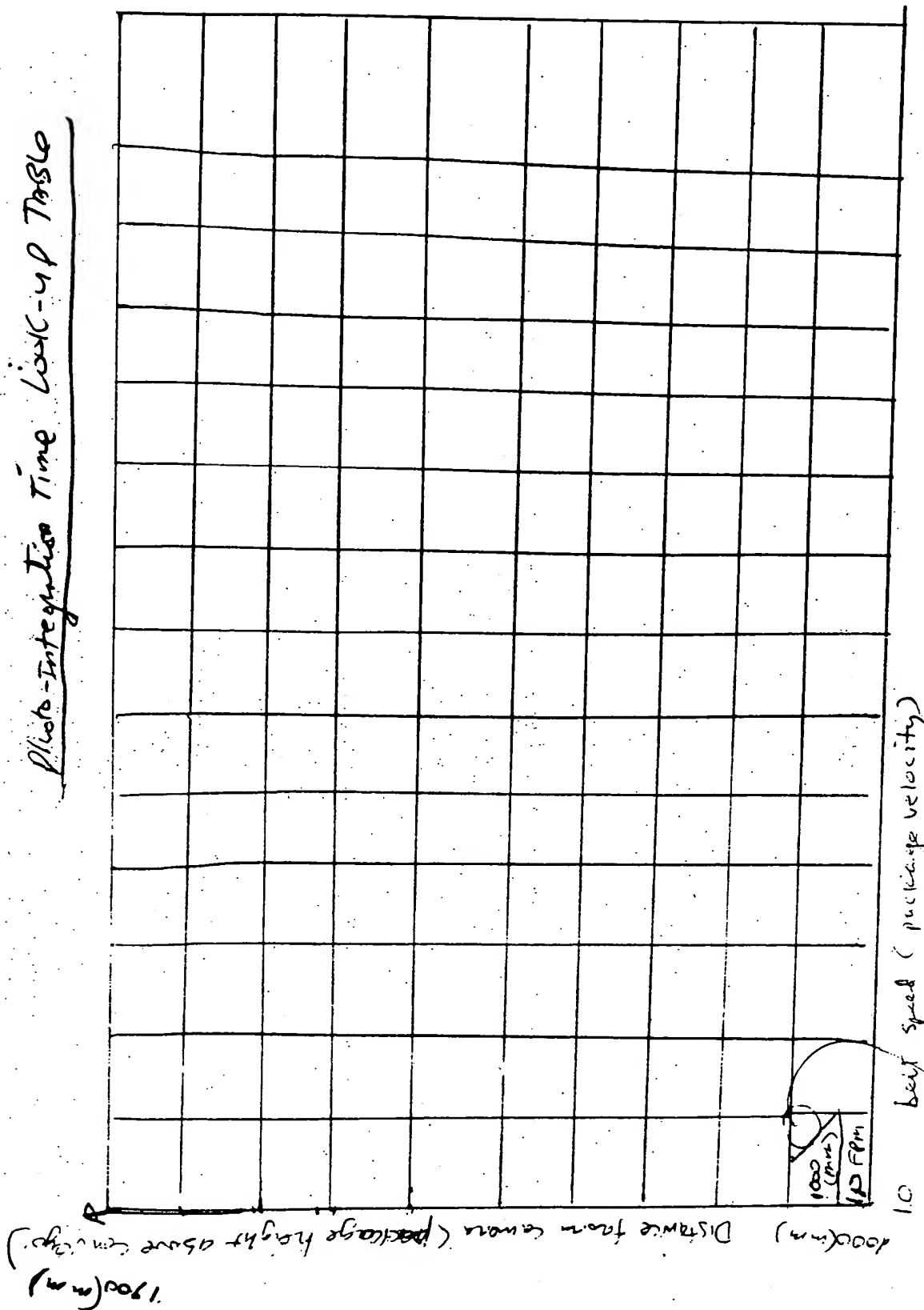
conveyor-belt surface

FIG. 28

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# Photo-Integration Time Look-Up Table



600 feet per minute  
(FPM)

FIG. 29

Photo integration  
Time video feed  
Camera square image pixel  
(1, 1 aspect ratio)

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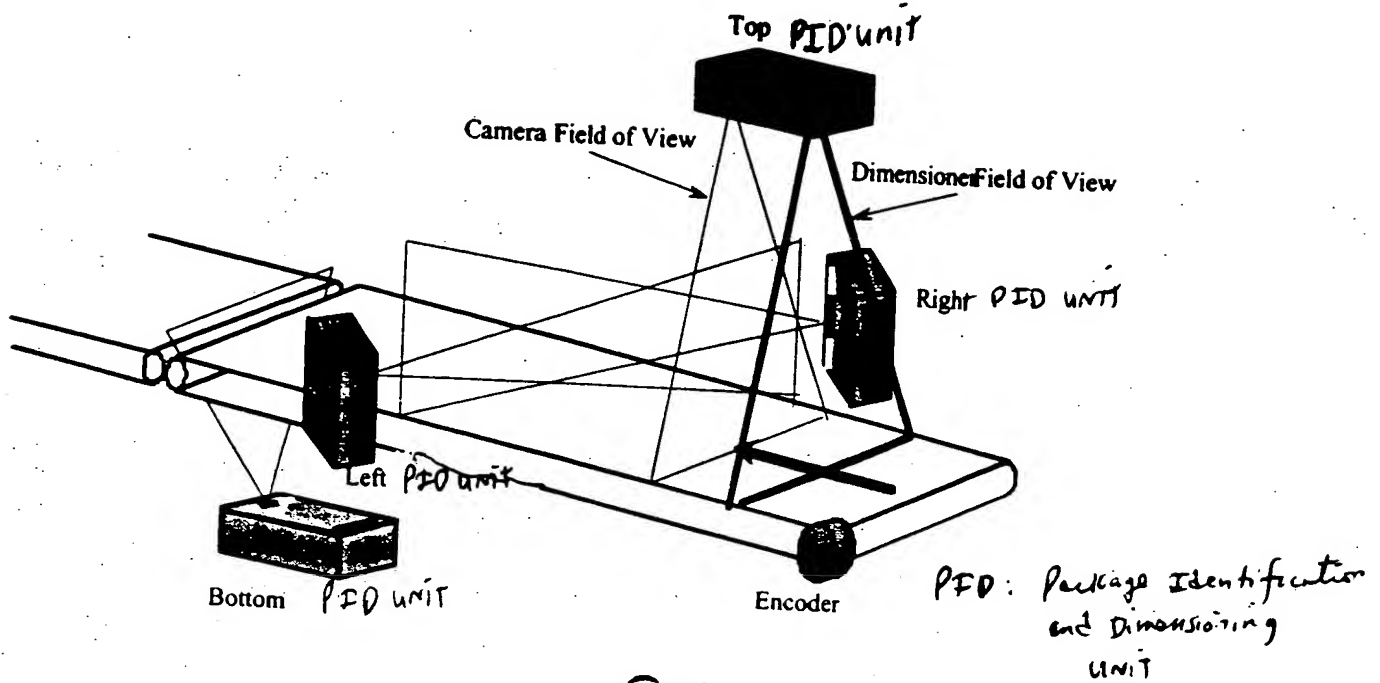


FIG. 30

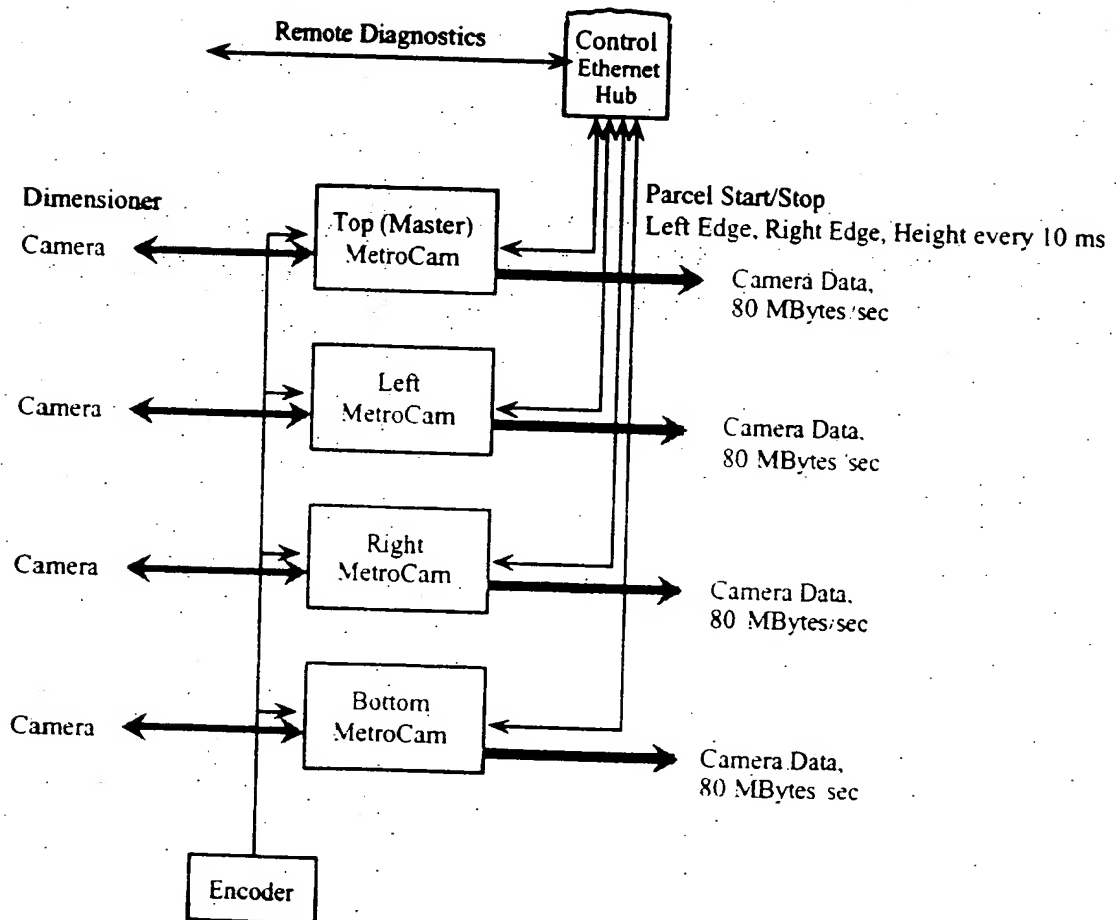


FIG. 31

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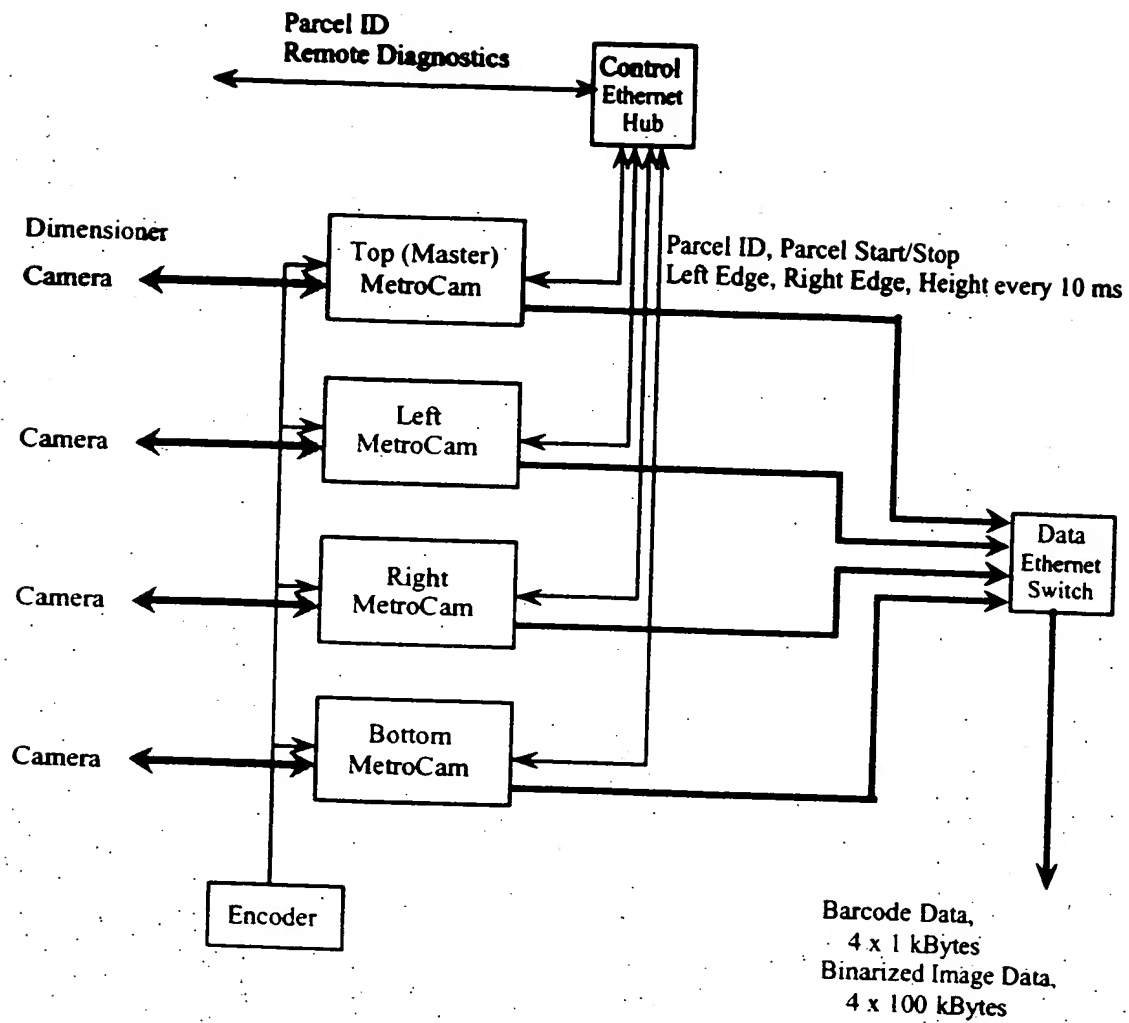


FIG. 32